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An Experimental Evaluation of the Descriptive Effectiveness of the Cusp Catastrophe Model in Simulated Bargaining Situations.

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AN EXPERIMENTAL EVALUATION OF THE DESCRIPTIVE EFFECTIVENESS OF THE CUSP CATASTROPHE MODEL IN SIMULATED BARGAINING SITUATIONS

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ABSTRACT

It is often difficult to describe the dynamics of system behavior, for example, collective bargaining type behavior. One reason for the difficulty in modelling such situations has been the lack of modelling techniques that can handle abrupt changes in the behavior of the system. However, Rene Thom's catastrophe theory has provided some new insights into phenomena involving sudden transitions.

The cusp catastrophe model presented in this study takes into account the possibility of multi-valuedness of the response variable. The model provides a rational explanation of phenomena having the following characteristics: Bimodality, sudden transitions, hysteresis, inaccessibility, and divergence. This paper attempts to empirically verify the usefulness of the cusp model in describing the dynamics of system behavior in simulated bargaining situations.

The cusp model is illustrated by a data set generated by simulating a collective bargaining process. The simulation consisted of 35 teams (of four subjects each) participating in a collective bargaining game. The data set consisting of 258 samples of hour-long rounds of formal negotiations provided data on the demand intensities of the bargaining subjects, the expected and observed system behavior. Statistical analysis indicated that the cusp model is a good fit for observed system behavior in simulated bargaining situations.

While the results indicated possible usefulness of the cusp model, a more definitive study using larger sample sizes and alternative

designs might establish the descriptive effectiveness of the model more conclusively. Hopefully, this preliminary study is the first step in the attempt at empirical verifications of the value of some of the catastrophe models in social sciences and business research.

CHAPTER I

OVERVIEW

Increased understanding of the nature of human conflict and its resolution has been one of the primary objectives of social scientists. The work of von Neumann and Morgenstern, The Theory of Games and Economic Behavior (1947) provided a new direction in this area by reinforcing the economic theory of conflicts with mathematics and general methodology.[1]

The theory of games deals with decisions; it is a normative theory indicating how rational players can be expected to make decisions. There are constant-sum games, cooperative and non-cooperative non-constant-sum games.[2] However, the theory is not a descriptive theory in that it does not describe how people actually make decisions.[3] In actual situations, often interests of people are partly coincident and partly opposed, indicating a tendency to cooperate to further common interests and a tendency to compete to enhance their own individual interests. Thus, the basic problem stems from the fact that while the parties at conflict are independent in their roles as decision makers,

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[1] J. von Neumann and O. Morgenstern, The Theory of Games and Economic Behavior (Princeton: Princeton University Press, 1947).

[2] J.C. Harsanyi, "Rationality Postulates for Bargaining Solutions in Cooperative and Non-cooperative Games," Management Science, 9, (1962), pp. 141-153.

[3] A. Rapoport, M.J. Guyer and D.G. Gordon, The 2 x 2 Game, (Ann Arbor: The University of Michigan Press, 1976), p. 3.

their welfare is mutually dependent.[4] Businessmen, administrators, and military strategists are frequently involved in such decision making behavior. Situations of this nature include union-management collective bargaining, peace negotiations in international relations, etc., and may be termed as collective bargaining type situations.

Since real life situations are rather complex, it is often desirable to design situations where bargaining behavior can be observed in order to draw some inferences on conflicts in general. Such gaming experiments may be termed as simulated bargaining situations. However, since simulations involving human behavior are not easily reproducible, the inferences one might draw from them may be of limited relevance in the construction of theories of conflict resolution.[5] On the other hand, these simulations must be undertaken as a first step in systematically describing certain aspects of the dynamics of conflict.

This study is concerned with simulated bargaining situations of the nature of union-management collective bargaining. Union-management collective bargaining is perhaps one of the more typical of collective bargaining type situations. In this context, collective bargaining is the institutional process for solving problems involving employer-employee relationship. A significant part of this process is the negotiation between the company and union representatives in an effort to reach agreement on the terms and conditions of employment.

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[4] L.E. Fouraker and S. Siegel, Bargaining Behavior, (New York: McGraw-Hill Book Company, Inc., 1965), pp. 94-96.

[5] A. Rapoport, et al., p. 11.

The bargaining behavior of such a system may be assumed to range from strike to lockout, including the more common position of mutual agreement. Stagner and Rosen[6] postulate that both bargaining parties have certain expectations and tolerance limits which define a bargaining zone (see Figure 1). As the parties bargain, they explore these limits in an effort to find an area in which a compromise is possible. If these limits are exceeded, a strike or a lockout may result. This model appears to be a good description of the collective bargaining process in general, but is essentially a static model.

Until recently, relatively fewer attempts appear to have been made in understanding the dynamics of formal negotiations. According to Hicks and Gullet[7] little analysis of interorganizational behavior has been done, and they believe that progress is sorely needed in this area. One reason for the difficulty in modeling such situations has been the lack of techniques that can handle abrupt changes in the behavior of the system such as strikes and lockouts. However, a relatively new area of mathematics research called catastrophe theory has opened up some interesting possibilities. This theory has been used to model cause and effect processes. The originator of this theory, Thom[8], has provided a breakthrough in the modeling of complex dynamic behavior, in which con-

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[6]R. Stagner and H. Rosen, Psychology of Union-Management Relations, (Belmont, California: Wadsworth Publishing Company, 1965), pp. 94-6

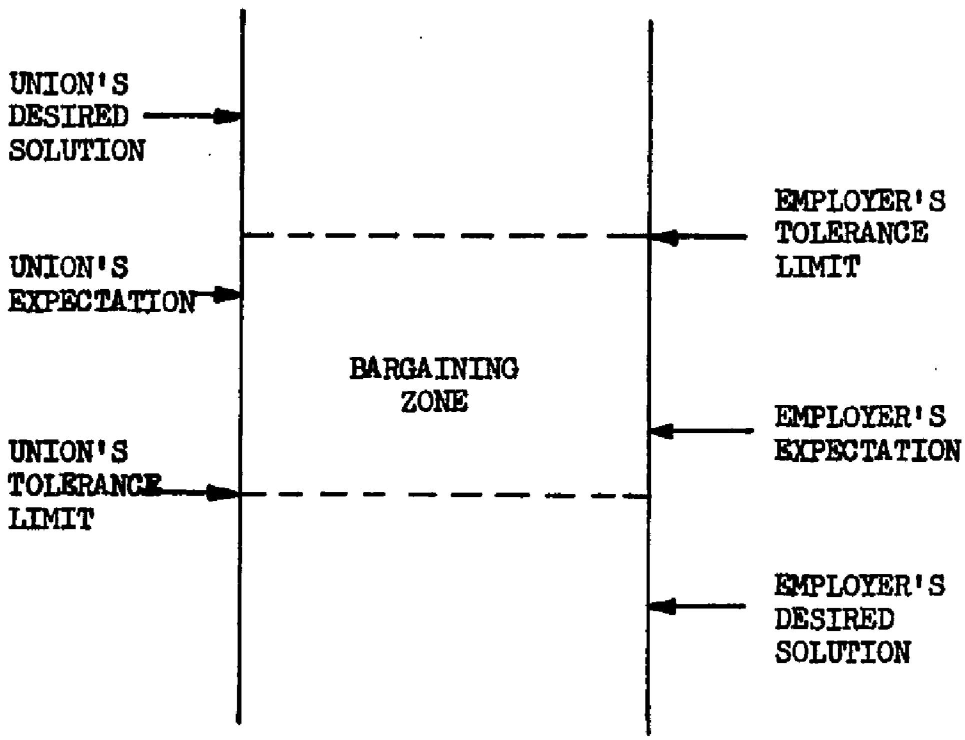
[7]H.G. Hicks and C.R. Gullet, The Management of Organizations (3d ed.), (New York: McGraw-Hill Book Company, Inc., 1976), p. 168.

[8]R. Thom, Structural Stability and Morphogenesis, (New York: W.A. Benjamin, Inc., 1975).

FIGURE I

STAGNER-ROSEN MODEL FOR BARGAINING BEHAVIOR

(Adapted from Stagner and Rosen, 1965)



tinuous changes can cause discontinuous effects. His pioneering book, Structural Stability and Morphogenesis (1975), provides the conceptual framework for catastrophe theory. This theory has been applied during the past five years in many disciplines, including physics, biology, social sciences, economics, and psychology. Catastrophe theory has provided new insights into phenomena involving sudden transitions. Based on differential topology, the mathematical proofs of the theorems are rather difficult to comprehend; however, the theory easily lends itself to many interpretations and applications.

Based on the Stagner-Rosen description of collective bargaining behavior, Oliva and Capdevielle[9] have conceptualised an application of one of the catastrophe models, the cusp model[10] to collective bargaining situations to help explain the dynamics of the system behavior. In a broad sense, their model attempts to examine the system behavior in terms of two variables: management demand intensity and union demand intensity. The purpose of this study is to examine the descriptive effectiveness of the cusp model by evaluating its validity in simulated bargaining situations. Of the several applications of catastrophe theory, relatively fewer models appear to have been tested even in laboratory experiments. According to Sutherland[11], empirical validation of models

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[9] T.A. Oliva and C.M. Capdevielle, "Collective Bargaining as a Catastrophe Model," Proceedings of Academy of Management (1977a).

[10] A detailed description of the cusp model is presented in Chapter II.

[11] J.W. Sutherland, Systems: Analysis, Administration, and Architecture, (New York: Von Nostrand Reinhold Company, 1975).

is a critical feature of system approach. Therefore, to be consistent with the system appreach, validation exercises must be undertaken to examine the descriptive effectiveness of the models. However, such exercises need only be aimed at application situations, since validity of an application would automatically reflect on the validity of the conceptual model. In this sense laboratory testing of collective bargaining behavior appears to be a promising way to explore the validity of the cusp model. To accomplish this purpose several working hypotheses were proposed.[12]

This study has focused on two variables, management demand intensity and union demand intensity; the experimental procedure adopted in this study eliminates other variables which may well be important in bargaining. The data collection has focused on the relative perception of the variables (not their absolute amounts).[13] The scope of this research is thus confined to simulated bargaining situations involving these two variables.

PLAN OF DEVELOPMENT

In Chapter II a review of background information relevant to this study is presented. After discussing some basic concepts of bargaining behavior, the chapter evaluates the merits of the descriptive and normative approaches in this area, with particular reference to collec-

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[12] The working hypotheses are presented in Chapter III.

[13] A. Scodel, J.S. Minas, P. Ratoosh and M. Lipetz, "Some Descriptive Aspects of Two-Person Non-Zero Sum Games," Journal of Conflict Resolution, 3, (1959), pp. 114-119. According to the authors, relative standing seems more important than absolute benefits in conflicts.

tive bargaining situations. Next, catastrophe models are presented in general without their mathematical derivations, followed by a more detailed description of the cusp model. The application of the cusp model to collective bargaining situations is explained in terms of isomorphic relationship between the two. Illustrations are provided to help explain the bargaining behavior of the system in terms of management and union demand intensities.

Chapter III discusses the research methodology and the procedures for collection of data. The chapter begins by some of the key definitions, and explains the subjects,procedures and instruments for data collection. The instruments used for data collection are a psychological insight test questionnaire and a collective bargaining game. The chapter also contains statements of working and formal hypotheses, and procedures for the analysis of data. The chi-square test for goodness of fit was adopted for testing the hypotheses. The collective bargaining game consists of negotiation of a hypothetical agreement between preselected pairs of subjects. The selection of subjects is based on their responses to the psychological insight test questionnaire. The demand intensities of the participants are measured in successive rounds of negotiations and the actual behavior of the system is recorded. The expected behavior of the system is estimated from the cusp model, and tested for statistical significance. The chapter finally discusses the experimental procedure in general.

The results of the research and the findings are presented in Chapter IV. Chapter V contains a discussion of results and the conclusions of this inquiry. Finally some suggestions for further research are proposed.

CHAPTER II

REVIEW OF RELEVANT LITERATURE

INTRODUCTION

The purpose of this chapter is to present a review of the literature relevant to this study. The first part is an introduction of various concepts relating to bargaining behavior in general and collective bargaining behavior in particular, and a broad discussion of some of the existing models. The second part takes a look at a new generation of models called catastrophe models. Some of the basic concepts underlying catastrophe theory are introduced and the implications of these models are briefly outlined. The cusp catastrophe model is examined in detail since it is the specific structure chosen for this research. The third part examines a model of collective bargaining behavior by establishing an isomorphism between collective bargaining phenomenon and the cusp model.

CONFLICTS AND CONFLICT RESOLUTION

In a broad sense, conflict presupposes clashes of values and interests between groups of individuals.[1] According to Walton and McKersie,[2] the intergroup conflicts may arise when there is an interaction

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[1] W.J. Scott and T.R. Mitchell, Organization Theory: A Structural and Behavioral Analysis (Homewood, Illinois: Richard D. Irwin, Inc., 1972), p. 189. For a typology of conflicts and causes, see T.V. Bonoma, "Conflict, Cooperation and Trust in Three Power Systems," Behavioral Science, 21 (Nov. 1976), pp. 499-514.

[2] R.E. Walton and R.B. McKersie, A Behavioral Theory of Labor Negotiations (New York: McGraw-Hill Book Company, 1963), p. 3.

of two or more complex social units which are attempting to define or redefine the terms of their interdependence. In an abstract sense, conflict arises when two or more entities try to occupy the same state-space, but only one can do so.[3]

Conflict resolution involves a search for an outcome which represents for some participants an improvement from, and to no participants a worsening of, their present situation.[4] However, in some instances, the resolution may result in gains for some participants at the expense of others. In general, there is a diversity of opinion about the origins, functions, and resolution of conflict among behavioral scientists.

March and Simon indicate four common outcomes of intergroup conflicts:[5]

1) Problem-solving behavior,
2) persuation,
3) bargaining, and
4) political behavior.

In problem solving, the conflicting units seek the most effective means for reaching agreed upon goals. In persuation, each unit

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[3]D.R. Hampton, C.E. Summer and R.A. Webber, Organizational Behavior and the Practice of Management (Glenview, Illinois: Scott, Foresman and Company, 1973), p. 671.

[4]J.M. Alexander and T.L. Saaty, "The Forward and Backward Process of Conflict Analysis," Behavioral Science, 22 (Mar. 1977), p. 87.

[5]J. March and H. Simon, Organizations (New York: John Wiley and Sons, 1958), pp. 121-129. For a somewhat similar analysis of conflict resolution see S. LaTour, P. Houlden, L. Walker and J. Thibaut, "Some Determinants of Preference Modes of Conflict Resolution," Journal of Conflict Resolution, 20 (June 1976), pp. 319-356. The authors discuss conflict resolution procedures arranged along a continuum of decreasing third-party intervention.

tries to persuade the other unit to accept its goals as legitimate. Once goals are agreed upon, it is relatively easy to find the most effective means for reaching them. In bargaining, goal conflict is explicit and recognized, but there is some agreement on the procedures that may legitimately be employed for resolving the conflict. In politics, there is total disagreement not only on goals but on the means by which the conflict may be resolved.[6] The assumption in the first three outcomes is that although there is conflict, agreement is possible; and that the factors that significantly affect these conflicts are interdependence, goal and perceptual differences. In a majority of intergroup conflicts, the process of bargaining is believed to have broad appeal.

BARGAINING

Bargaining implies bilateral negotiation.[7] It is defined as a process where:

1) there are two or more parties with diverging interests,
2) the parties can communicate,
3) mutual compromise is possible,
4) provisional offers can be made, and
5) the provisional offers do not fix the tangible outcomes until an offer is accepted by all sides.[8]

Thus bargaining is said to occur when parties at conflict confer and exchange ideas about a possible settlement until either a compromise is reached or the bargaining is terminated.[9]

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[6] Loc. cit.

[7] S. LaTour, et al., op.cit., p. 320.

[8] J.M. Chertkoff and J.K. Esser, "A Review of Experiments in Explicit Bargaining," Journal of Experimental Social Psychology, 12 (Sept. 1976), p. 464.

[9] Ibid.

The social patterns of stress, conflict, and bargaining are inevitable in a changing environment.[10] Chertkoff and Esser[11] suggest that bargaining is a pervasive and important phenomenon; it occurs between individuals, groups, organizations and countries. Examples include union-management disputes, international disputes, territorial disputes, price disputes, and even domestic disputes. Bargaining behavior of the system is the end result of decision making behavior[12] of the participants. Compromise and impasse in formal negotiations are examples of the bargaining behavior of the system.[13]

The current approaches to the study of phenomena involving bargaining behavior fall into two distinct classes: descriptive and normative. The descriptive approach attempts to describe how real people make decisions in situations involving conflicts of interests; while the normative approach attempts to discover how certain idealized actors, called rational players, can be expected to make decisions in such situations.[14]

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[10] C. Barnard, The Functions of the Executive (Cambridge, Mass.: Harvard University Press, 1950), p. 36.

[11] J.M. Chertkoff and J.K. Esser, op. cit., p. 464.

[12] Some authors refer to this as choice behavior: S. Siegel, A.E. Siegel and J.M. Andrews, Choice, Strategy and Utility (New York: McGraw-Hill Book Company, 1964).

[13] L.C. Megginson, Personnel and Human Resources Administration (Homewood, Illinois: Richard D. Irwin, Inc., 1977), pp. 523-525.

[14] A. Rapoport, M.J. Guyer and D.G. Gorden, The 2 x 2 Game (Ann Arbor: The University of Michigan Press, 1976), p. 33.

DESCRIPTIVE MODELS

Traditionally, bargaining behavior was assumed to be a function of relative bargaining power of the parties at conflict. Pigou[15] described bargaining in terms of upper and lower limits of the demands of the participants leading to two types of bargaining behavior: a compromise in a range of practical bargaining, and an impasse with no area for practical bargaining.

Terhune[16] has developed a modified Lewinian model for two-person interaction behavior:

$$B_{ij} = f\,(P_i P_j,\ S_k)\ ,$$

where B_{ij} = Interaction behavior of the system comprising individuals i and j,

$P_i P_j$ = The system qualities defined as the configuration of personalities within the system, as may be indicated, for example by a multiplicative sum of relevant personality dimensions, and

S_k = Contributions of the situation within which the actors are behaving.

Terhune refers to interaction behavior of the system in terms of cooperation, exploitation, and conflict.[17]

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[15] A.C. Pigou, The Economics of Welfare 4th ed. (London: Macmillan & Co., Ltd., 1933), pp. 450-461. For a comparative discussion of Pigou's model see L.C. Megginson, op. cit., pp. 525-526. A more detailed discussion of bargaining theories from the behavioral point of view is provided in R.E. Walton and R.B. McKersie, op. cit. See also by the same authors, "The Theory of Bargaining," Industrial and Labor Relations Review, (April 1966), pp. 414-424.

[16] K.W. Terhune, "Wash-in, Wash-out and Systemic Effects in Extended Prisoner's Dilemma," Journal of Conflict Resolution, 18 (Dec 1974), pp. 680-683.

[17] In this model, interaction behavior of the system has the same implication as bargaining behavior of the system. Although the model was developed to explain interaction behavior in Prisoner's Dilemma situations, it applies in general to the process of bargaining.

In a general sense, the descriptive models attempt to relate the bargaining behavior of the system with the behavioral/situational variables.[18] However, contributors in this area appear to differ as to the relative importance of some of the specific determinants of bargaining behavior.

NORMATIVE MODELS

The origin of normative models may be traced to the work of von Neumann and Morgenstern, The Theory of Games and Economic Behavior.[19] Game theory can be formally defined as a theory of rational decision in conflict situations. Models of such situations involve:[20]

1) a set of decision makers, called players,
2) a set of strategies available to each player,
3) a set of outcomes, each of which is a result of particular choices of strategies made by the players on a given play of the game, and
4) a set of payoffs accorded to each player in each of the possible outcomes.

There are two classes of models in game theory: the constant-sum (special case: zero-sum) models and the nonconstant-sum models. In constant-sum games, the interests of players are diametrically opposed, and in nonconstant-sum games, these interests may partially coincide. Models are also sometimes classified with reference to the number of

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[18] For a recent review of a number of alternative approaches see M. Patchen, "Models of Cooperation and Conflict: A Critical Review," Journal of Conflict Resolution, 14 (Sept 1970), pp. 389-407; J.M. Chertkoff and J.K. Esser, op. cit.

[19] J. von Neumann and O. Morgenstern, The Theory of Games and Economic Behavior (Princeton: Princeton University Press, 1947).

[20] A. Rapoport (ed.), Game Theory as a Theory of Conflict Resolution (Dordrecht, Holland: D. Reidel Publishing Company, 1974), pp. 1-3.

players, and according to the degree of freedom in choice of strategies; these strategies could be mixed (probabilistically chosen) or pure.

The constant-sum models are based on the assertion that there exists, available to each player, at least one optimal strategy, which may be pure or mixed.[21] A player choosing such an optimal strategy can guarantee himself a certain minimal payoff; this means that each player can keep the other's payoff down to the latter's guaranteed minimum. The resulting outcome of the game is called equilibrium; it is Pareto-optimal if there is no other outcome in which both players get a larger payoff. It is then possible to prescribe an optimal strategy to each player; if both players follow this prescription, each will do as well as he possibly can in that game (against a rational player). Von Neumann and Morgenstern also show that if there are several equilibria, determined by paired choice of optimal strategies, then they will all be equivalent and interchangeable.[22] Implication of these models is that if one player keeps to his optimal strategy, the other can not improve his payoff by shifting away from his own optimal strategy, he may actually impair his payoff in the process.

Solutions of nonconstant-sum games involving more than two players are less satisfactory in a normative sense. These games are further classified as non-cooperative and cooperative games depending on whether the choices of strategies must be made independently or coordinated. These are games in which the interests of the players partially

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[21] J. von Neumann and O. Morgenstern, loc. cit.

[22] Ibid.

coincide in that both may prefer one outcome to another. Although every non-cooperative game with a finite number of players and strategies has at least one equilibrium,[23] there could be several equilibria that are not necessarily equivalent or interchangeable. Further, these equilibria are frequently, Pareto-deficient. Harsanyi[24] tries to overcome some of these difficulties by allowing communication and bargaining in non-cooperative games. The possibility of communication and bargaining is said to greatly facilitate the establishment of a unique solution. However, Harsanyi assumes that the players are not able to make enforceable agreements and excludes nonequilibrium strategy pairs from consideration as solutions.[25]

The theory of cooperative games introduces communication, bargaining and enforceable agreements into game-theoretic concepts as possible means of arriving at Pareto-optimal solutions. In a cooperative game, although the interests of the players can be and generally are in (partial) conflict, it still makes sense for them to cooperate in order to ensure Pareto-optimality of the outcome. If the game has more than one such outcome, it is among them that the preferences of the players are in conflict.[26] Such a game is also a nonconstant-sum game since there are outcomes that are preferred by both players to other outcomes.

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[23] J.F. Nash, "Equilibrium Points in N-Person Games," Proceedings of the National Academy of Sciences (USA), 36 (1950), pp. 48-49.

[24] J.C. Harsanyi, "Rationality Postulates for Bargaining Solutions in Cooperative and Non-Cooperative Games," Management Science, 9 (1962), pp. 141-153.

[25] Ibid.

[26] A. Rapoport (1976), op. cit., p. 50.

Rapoport's example of simple bargaining involves a seller and a buyer; the seller is willing to sell an object at any price above a certain minimum price. If the maximum price the buyer is willing to pay is less than the minimum price the seller is willing to accept, obviously no agreement is possible; however, if the buyer's maximum exceeds the seller's minimum, there exists a negotiation set (which may also be considered as a single-valued curve of possible rational solutions). This situation is called elementary bargaining problem (Figure II), and its solution is assumed to be contingent upon symmetry, Pareto Optimality, independence from irrelevant alternatives, and invariance under positive linear transformations.[27] Different methods of solving this problem are available.[28] These solutions have preserved lesser normative flavor in terms of prescribing rational decision-making behavior, as compared with the constant-sum games. A special case of nonconstant-sum game called "Prisoner's Dilemma" has posed a fundamental question for proponents of normative models. The question "What is rational choice?" in this situa-

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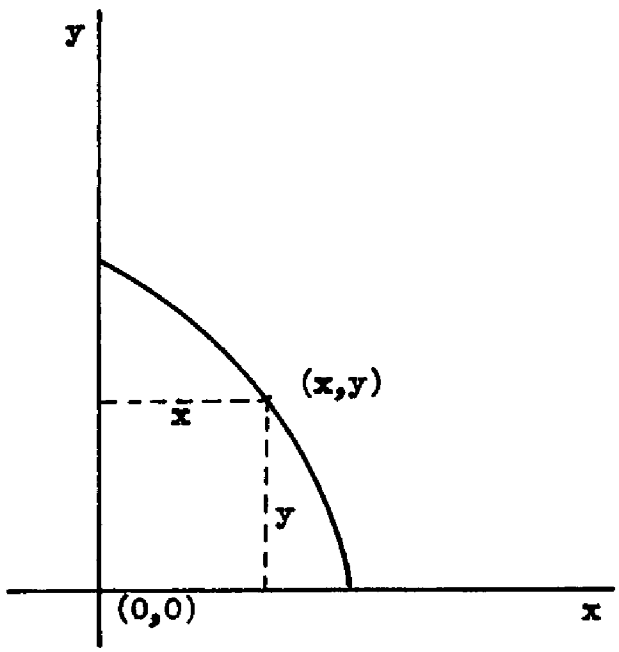
[27] A. Rapoport, "Conflict Resolution in Light of Game Theory," in P. Swingle (ed.), The Structure of Conflict (New York: Academic Press, 1970), pp. 1-42. Variations of the elementary bargaining problem are discussed by several authors. They attempt to explore the effects of certain factors relating to initial conditions, magnitude and frequency of concessions, and information about payoffs upon bargaining behavior. For more details, see G.A. Yukl, "Effects of Opponent's Initial Offer," Journal of Personality and Social Psychology, 30, (1974), pp. 325-335; J.M. Chertkoff and J.K. Esser, op. cit.; D. Druckman and T.V. Bonoma, "Determinants of Bargaining Behavior in a Bilateral Monopoly Situation II: Opponent's Concession Rate and Similarity," Behavioral Science, 21, (July 1976), pp. 252-262; D.S. Felsenthal, "Bargaining Behavior when Profits are Unequal and Losses are Equal," Behavioral Science, 22, (Sept 1977), pp. 334-340.

[28] J.F. Nash, "The Bargaining Problem," Econometrics, 18, (1950), pp. 155-162. For recent work on Nash's model, see R.V. Nydegger,

FIGURE II

THE UTILITY PAYOFF SPACE OF THE ELEMENTARY BARGAINING PROBLEM

(Adapted from A. Rapoport, "Conflict Resolution in the Light of Game Theory," in P. Swingle (ed.), The Structure of Conflict, New York, Academic Press, 1970, pp. 10-13)



Legend: Curve : the negotiation set
Origin: the status quo point
(x,y) : a possible outcome

x : Utility gain of Player 1
y : Utility gain of Player 2

Solution: Of all possible rectangles with one corner at the Origin and another on the negotiation set, the rectangle that has the largest area defines the solution to the bargaining problem.

tion centers around two concepts of rationality, namely individual rationality and collective rationality.[29]

COLLECTIVE BARGAINING

A special type of bargaining commonly known as collective bargaining occurs in union-management disputes, international disputes, territorial disputes, etc. Situations of this nature will be referred to as collective bargaining type situations. According to Davis,[30] it is essentially a compromise and balancing of opposing pressures; and the objective of collective bargaining is to work toward a new equilibrium of social forces and to make it easier to maintain this equilibrium.

Megginson[31] defines collective bargaining as a social, as well as a legal and economic process. In the context of Union-management conflict, collective bargaining is the institutional process for solving problems involving terms and conditions of employment via formal negotiations. Such negotiation normally culminates in the signing of a written instrument, termed labor agreement or union contract, which sets

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"Independent Utility Scaling and the Nash Bargaining Model," Behavioral Science, 22, (July 1977), pp. 283-289; M. Simaan and J.B. Cruz, Jr., "Nash Equilibrium Strategies for the Problem of Armament Control," Management Science, 22, (Sept 1975), pp. 96-105.

[29] A. Rapoport (1974), op. cit., pp. 17-34. Between 1952 and present, several hundreds of experimental studies have been reported on Prisoner's Dilemma. This game has brought to focus some of the limitations of normative approaches to choice behavior.

[30] K. Davis, Human Behavior at Work (New York: McGraw-Hill Book Company, 1972), p. 278.

[31] L.C. Megginson, Personnel: A behavioral Approach to Administration (Homewood, Illinois: Richard D. Irwin, Inc., 1972), p. 173.

forth the terms and conditions of employment for a fixed period of time. However, disruptive labor-management relationships may also develop during the negotiations, in the form of threatened or actual strikes and lockouts.

Kochan-Wheeler description of the collective bargaining process postulates that the relationships between environmental characteristics union and management organizational characteristics, and the bargaining process determine the bargaining outcomes.[32]

Stagner and Rosen[33] have proposed a more specific description of collective bargaining behavior in terms of motivation, perception, organization and leadership as the basic variables which manifest in the form of desires and expectations (see Figure I in Chapter I):

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[32]For more details see T.A. Kochan and H.N. Wheeler, "Municipal Collective Bargaining: A Model and Analysis of Bargaining Outcomes," Industrial and Labor Relations Review, 29 (Oct. 1975), pp. 46-66. A similar description may be found in P.F. Gerhart, "Determinants of Bargaining Outcomes in Local Government Labor Negotiations," Industrial and Labor Relations Review, 29 (Apr 1976), pp. 331-351.

[33]R. Stagner and H. Rosen, Psychology of Union-Management Relations (Belmont, California: Wadsworth, Inc., 1965), pp. 90-96. Similar description of bargaining behavior as a function of behavioral variables may be found in S.H. Slichter, J.J. Healy and E.R. Livernash, The Impact of Collective Bargaining on Management (Washington, D.C.: The Brookings Institution, 1960); R.E. Walton and R.B. McKersie, A Behavioral Theory of Labor Negotiation, op. cit.; M.S. Wortman and C.W. Randle, Collective Bargaining Principles and Practice (Boston: Houghton Miffin Co., 1966); H.M. Levinson, Determining Forces in Collective Bargaining (New York: John Wiley & Sons, Inc., 1966); L.C. Megginson and C.R. Gullet, "A Predictive Model of Union-Management Conflict," Personnel Journal (June 1970); J.B. Miner and M.G. Miner, Personnel and Industrial Relations: A Managerial Approach (New York: MacMillan & Co., Ltd., 1973); F.H. Cassel and J.J. Baron, Collective Bargaining in the Public Sector (Columbus: Grid Inc., 1975); S.W. Gellerman, Managers and Subordinates (Hinsdale, Illinois: The Dryden Press, 1976); and L.C. Megginson (1977), op. cit.; T.A. Kochan and H.N. Wheeler, op. cit.; and P.F. Gerhart, op. cit. In a general sense, the Stagner-Rosen description seems to have broad appeal.

> Both parties bring certain expectations to the negotiations. It is general practice for each group to write its own expectations into proposals for the new contract.... Similarly, each side is likely to have, at the beginning of negotiations, an idea of the limit beyond which it will make no concessions. This limit results in a bargaining zone for each side, with the preferred solution on one end and the tolerance limit on the other..... As the parties bargain, they explore these limits and, hopefully, find an area in which a compromise is possible. For both sides, there is a bargaining zone between the employer's tolerance limit and the union tolerance limit..... Each side can always find some instances to support the "wished for" solution; and each side will tend to ignore the evidence presented by the opposition. Nevertheless, communication does take place; each takes cognizance of the data, and the acceptability shifts. Management moves up a little, and the union moves down a little, until an acceptable point for both is reached.[34]

The Stagner-Rosen model also implicitly recognizes the bargaining behavior of the system when the tolerance limits of the participants is reached. The implication is that when the union tolerance limit is reached, rather than yielding further, the union may declare a strike; and a lockout may result if the management perceives that its tolerance limit has been reached.[35]

DISCUSSION OF CURRENT APPROACHES

There seem to be some new trends in building descriptive and predictive models of bargaining behavior. However, the proponents of descriptive models intuitively recognize that it is often difficult to

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[34] Ibid.

[35] For a somewhat similar description of bargaining behavior see E.R. Brown, "The Effects of Need to Maintain Face on Interpersonal Bargaining," Journal of Experimental Social Psychology, 4 (Mar. 1968), pp. 107-122.

describe the dynamics of bargaining behavior (even in a qualitative sense) especially in collective bargaining situations. For instance, company executives often confess that they had no idea the union would strike over an apparently minor demand,and union leaders sometimes err in estimating management's intensity of feeling:

> Both sides are human; managers have certain expectations about "management rights," which may trigger such strong emotions that rational bargaining is impossible. Unionists, likewise, have emotions, which sometimes prevent them from seeing issues realistically, so that they strike even though it cannot possibly lead to any net economic gain.[36]

Such is the complexity of collective bargaining type situations. Thus, one must reluctantly conclude that the existing descriptive models are essentially static and do not apperar to capture the dynamic properties of the system; they also seem to lack mathematical elegance and very few attempts appear to have been made to quantify the behavioral variables involved in the models.[37]

A major problem with the normative models is that these models attempt to predict how the participants ought to behave under assumptions about variables such as their rationality, information, preferences, and risk-taking propensities, instead of incorporating propositions that explain or describe how the participants act or the actual outcomes of the

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[36]R. Stagner and H. Rosen, op. cit.

[37]For specific criticisms and a more detailed discussion of some of the problems involved, see J.M. Chertkoff and J.K. Esser, op. cit., pp. 464-468. The authors suggest that the existing models suffer from one or more of the following problems: (1) There are measurement problems in quantifying the mediating factors, (2) the relations between possible variables and the mediating factors are no spelled out clearly, (3) the theories are stated so broadly and/or with so little precision

process. That is, the normative models are concerned with the structure of games and disregard such important factors as individual personalities of the players, their bargaining abilities, their relations to each other; the players are simply assumed to be "rational."[38] Additionally, the much publicized Prisoner's Dilemma has exposed the ambivalence of optimal strategy in general. The result is that there has been a heavy emphasis on experimental games involving predispositional variables such as personality, power, threats, etc. However, contributors differ as to the relative importance of structural vs. behavioral variables as determinants of bargaining behavior.

In summary, both descriptive and normative models have weaknesses; the descriptive models are static, and there are controversies about the extent of relevance of game-theoretic conclusions to collective bargaining type situations. Attempts to integrate game-theoretic formulations with experimental procedures in behavioral theory appear to be promising, but do not seem to adequately explain sudden transitions in bargaining behavior in general and collective bargaining behavior in particular.[39] Therefore, the descriptive effectiveness of these models

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that very few if any findings could ever lead to rejection or modification of the theories. These criticisms apply to the normative models as well in varying degrees.

[38] A. Rapoport and J. Perner, "Nash's Solution of Cooperative Game," in A. Rapoport (ed.), op. cit., p. 114.

[39] For recent work in this area see D. Druckman and T.V. Bonoma, op. cit. The authors observe that bargainers sometimes retaliate to the opponent's pressure by suddenly decreasing concessions, even rejecting the process completely. However, the explanation provided by the authors for such behavior appears to be rather limited in scope.

appears to be somewhat limited. Oliva and Capdevielle have suggested that some of these problems might be overcome by mapping the important characteristics of the Stagner-Rosen model onto the cusp catastrophe model.[40] A review of catastrophe theory and an explanation of the cusp catastrophe model are provided in the following sections.

CATASTROPHE THEORY

Catastrophe theory, a relatively new area of mathematics research, has provided a breakthrough in the modeling of complex dynamic behavior. The developer of the theory, Thom, has provided the conceptual framework for catastrophe theory in his book, Structural Stability and Morphogenesis.[41] According to Zeeman:

> .... The method has potential for describing the evolution of forms in all aspects of nature, and hence it embodies a theory of great generality; it can be applied with particular effectiveness in those situations where gradually changing forces or motivations lead to abrupt changes in behavior. For this reason the method has been named catastrophe theory.[42]

Phenomena involving sudden variations traditionally had been assumed to be outside the reach of mathematical treatment, because they lacked what was considered to be an essential precondition, the continuity of dependence relations between the variables.[43] The main thrust

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[40] T.A. Oliva and C.M. Capdevielle, "Collective Bargaining as a Catastrophe Model," Proceedings of Academy of Management, (1977a).

[41] R. Thom, Structural Stability and Morphogenesis (Reading, Massachusetts: W.A. Benjamin, Inc., 1975).

[42] E.C. Zeeman, "Catastrophe Theory," Scientific American (April 1976), p. 65.

[43] C.A. Isnard and E.C. Zeeman, "Some Models from Catastrophe

FIGURE III

Behavior of a Single-valued Function

(Adapted from Thom, 1977)

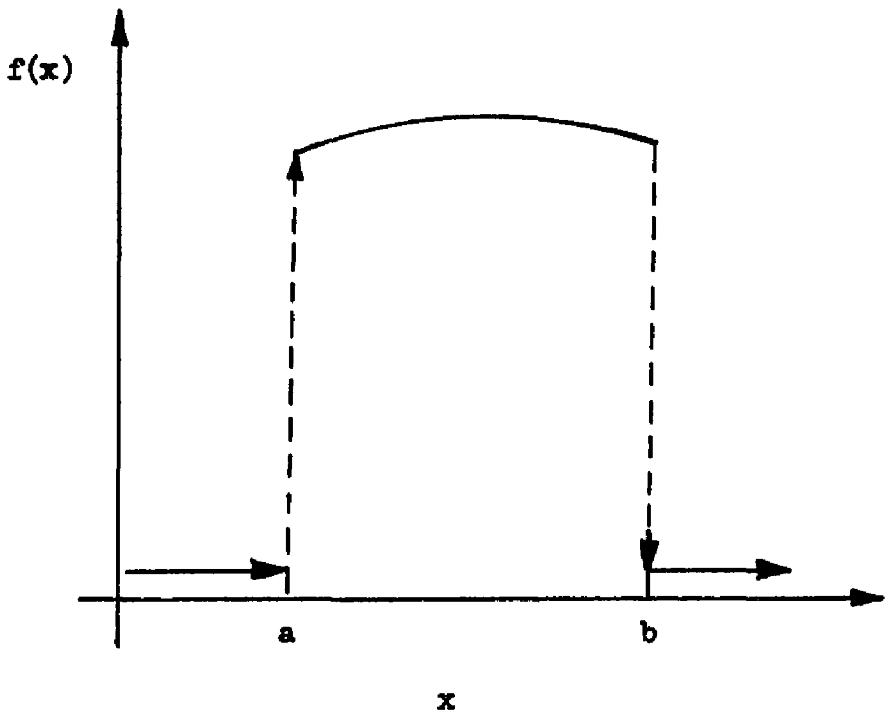
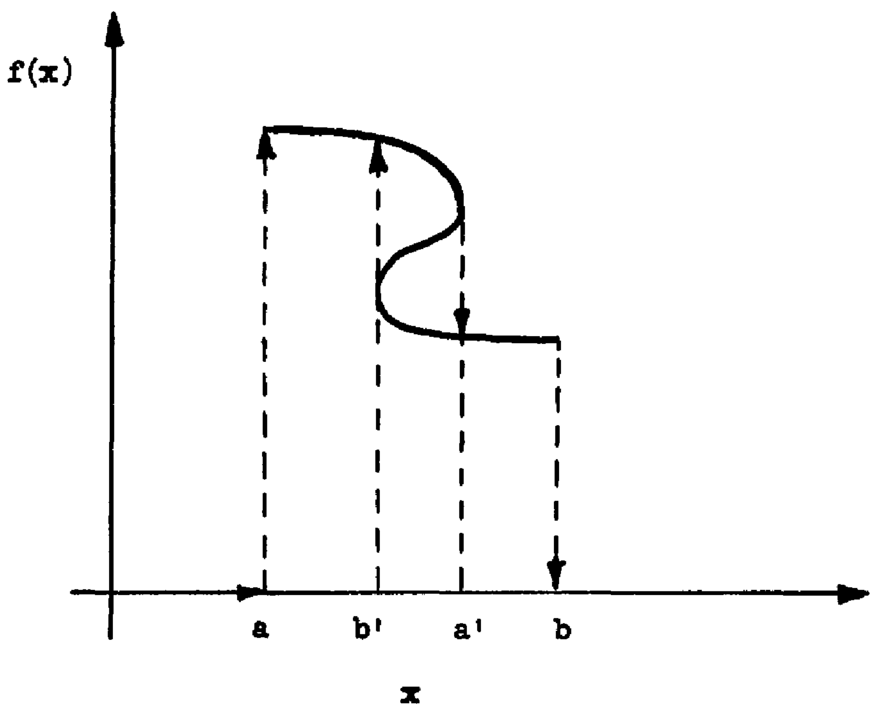


FIGURE IV

Behavior of a Multi-valued Function

(Adapted from Thom, 1977)



of catastrophe theory is the explanation of how gradually changing forces can cause discontinuous (catastrophic) behavior. According to Thom, "these phenomena are highly unstable, difficult to repeat, and hard to fit into a mathematical theory, because the characteristics of all form, all morphogenesis, is to display itself through discontinuities of the environment."[44] These sudden transformations and unpredictable divergences render the traditional mathematical models inadequate, since these models depend on the use of continuous (single-valued) functions. Thom[45] suggests that the use of single-valued functions may be inappropriate for modeling sudden transitions and unexpected divergences, and thus the traditional models often fail to capture the true causal relationships. In support of this "finite hypothesis," Thom has provided several illustrations.

Figure III shows a system defined by two single-valued parameters (a and b). Movement along the curve is possible only between the singularities. In the process of gradually changing the control variable, exceeding singularity b, or not reaching singularity a, would cause the system to break down. However, if the system is defined by parameters that can take on more than one value (represented by a behavior surface with a fold in the middle), gradual changes in the control variable would cause sudden changes at the singular points (see Figure IV).

Theory in the Social Sciences," in C. Collins (ed.) The Use of Models in the Social Sciences (Boulder, Colorado: Westview Press, 1976), p. 45.

[44]R. Thom, op. cit., p. 9.

[45]R. Thom, "Catastrophe Theory and its Applications," Pasqualle Porcelli Memorial Lecture (Baton Rouge, Louisiana: Louisiana State University, June 16, 1977).

Thom calls these sudden changes as catastrophes, and has shown that such changes occur as a result of local minimization of potential energy at the singularities.[46] The behavior of the system is said to be a function of possible families of potentials, and can be represented by structurally stable topological surfaces.[47] Topology is a branch of mathematics concerned with the properties of surfaces in many dimensions. Thom calls the shape of the structurally stable (equilibrium) surfaces as morphologies.[48] The preceeding arguments can be expressed mathematically as follows:[49]

Notation: Consider a process p in which C (cause) causes B (effect). Topologically C and B are smooth surfaces (also known as manifolds) and the process is usually expressed as $p : C \times B \rightarrow C$, that is, p takes a point C and processes it to generate a value on B, and this relationship may be studied by looking at C. This notation preserves the direction of causality in contrast with algebraic notation involving equations. The notation also implies that the process is smooth and real-valued, that is, the chain of causality is smooth and real. Points c on the surface C can be partitioned into "regular" points and "catastrophe" points. Regular points exhibit homeomorphism, that is, there exists a one-to-one map that is smooth and has a smooth inverse between B and C;

[46] Ibid.

[47] Ibid.

[48] Ibid.

[49] The mathematical notation is adopted from R. Thom (1975), op. cit., and E.C. Zeeman, "Applications of Catastrophe Theory," Tokyo International Conference on Manifolds (1973).

points not possessing this characteristic are called catastrophe points. Thom suggests that use of single-valued functions would be inappropriate to explain the catastrophe points. His method overcomes this difficulty by the use of multi-valued functions.

Suppose $f : R^k \times R^n \rightarrow R$ be a smooth function representing a dynamic system where R^k (the control surface) represents the cause (with $k \leqslant 5$), R^n (the behavior surface) represents the effect, and f represents a potential or an energy function. Then the system is said to attempt to locally minimize f. In a sense, the system adopts a minimax strategy as defined in game theory.[50] Thom believes that all conflicts evolve so as to minimize the damage that results.[51]

For any given control point $c \in R^k$, the local potential function $f_c : R^n \rightarrow R$ given by $f_c(x) = f(c,x)$ can be minimized locally by differentiating f_c with respect to x. Thus for any differential equation $\dot{x} = -\text{grad}_x\ f = 0$ defines local minima, where $x = (X_1, \ldots.\ x_n) \in R^n$, and $\text{grad}_x\ f = \text{grad}\ f_c = (\frac{\partial f}{\partial x_1}, \ldots.. \frac{\partial f}{\partial x_n})$. Then the stable equilibria are given by the minima of f_c. Since there is obviously more than one singularity x_c of f_c, x_c will be a multi-valued function $R^k \rightarrow R^n$. Now consider the maxima of f_c. Suppose $M_f \subset R^{k+n}$ when $\text{grad}_x\ f = 0$, where generically M_f is a k-manifold given by n equations, and $X_f = M_f^k \rightarrow R^k$ is the catastrophe map of f.

Thom's Theorem: If f is generic (i.e., belongs to an open-dense set), then (1) M_f is a k-manifold; (2) Any singularity of X_f

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[50] J. von Neumann and O. Morgenstern, op. cit.; the authors provide a detailed discussion of minimax theorem.

[51] R. Thom (1975), op. cit., p. 143.

is equivalent[52] to one of a finite number of elementary catastrophes (for $K \leqslant 4$, the number of elementary catastrophes = 7); and (3) X_f is stable[53] under small perturbations of f. (Proof of the theorem is not discussed here.)[54]

Catastrophe theory holds that discontinuities and divergences are mathematically natural and can be precisely handled. Thom argues that the behavior of a system can be represented by morphologies, and postulates that catastrophe theory is involved with morphogenesis (the genesis of form) in the Universe.[55]

According to Zeeman,[56] catastrophes occur when the equilibrium breaks down. Catastrophe theory attempts to describe the shapes of all possible morphologies. In particular, if the system is governed through potentials by at most a four-dimensional control, structurally stable catastrophes can occur in only seven ways as shown. These seven elementary catastrophes describe all possible discontinuities in phenomena controlled by no more than four factors, and are given by simple poly-

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[52] Two graphs X_1 and X_2 are equivalent in a qualitative sense if there is a diffeomorphism (a one-to-one map of the plane onto itself that is smooth and has smooth inverse) of the plane that maps vertical lines to vertical lines and maps X_1 to X_2. For more details see loc. cit.

[53] Stable means that X_f is equivalent to X_g for all g in a neighborhood of f.

[54] For a comparatively less rigorous proof see T. Poston and I. Stewart, "Thom's Classification Theorem: Intuitive Approach," in T. Poston and I. Stewart, Taylor Expansions and Catastrophies (Belmont, California: Pitman Publishing Corporation, 1976), pp. 22-76.

[55] R. Thom (1975), op. cit., p. 320.

[56] E.C. Zeeman, "Catastrophe Theory," Scientific American (April 1976), p. 78.

nominals (see Table I).[57]

In the preceeding table, each of the seven catastrophes is associated with a potential function in which the control parameters are represented as coefficients (a, b, c, d) and the behavior of the system is determined by the variables (x, y). The behavior surface in each model is the graph of all the points where the first derivatives are equal to zero.

Catastrophe theory has been applied in several fields including physics, biology, and social sciences. Some of the phenomena that have been explained using catastrophe models are: the catastrophe machine, aggression, committee behavior, national defense, economic growth, nerve impulse, phase transition, optical caustics, behavior of the stock market, buckling of elastic beams, population dynamics, and collective bargaining.[58]

Thom categorizes these applications as hard and soft applications and provides several examples from physics, biology, etc.[59]

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[57] Ibid., p. 65.

[58] These applications are discussed in E.C. Zeeman, "Applications of Catastrophe Theory," Tokyo International Conference on Manifolds (1973); "Catastrophe Theory," op. cit.; "On the Unstable Behavior of Stock Exchanges," Journal of Mathematical Economics 1, (1974); C.A. Isnard and E.C. Zeeman, "Some Models from Catastrophe Theory in the Social Sciences," op. cit.; T. Poston and A.E.R. Woodcock, "Zeeman's Catastrophe Machine," Proceedings of Cambridge Philosophical Society (1974), pp. 211-220; I. Stewart, "The Seven Elementary Catastrophes," New Scientist (Nov. 1975); L. Starobin, "Our Changing Evolution: Strategies for 1980," General Systems XXI (1976); W.S. Brown, "An Economic Application of Catastrophe Theory," Unpublished Ph.D. Thesis, University of Colorado (1977), and T.A. Oliva and C.M. Capdevielle, op. cit.

[59] R. Thom (1977), op. cit.

TABLE I

	CATASTROPHE	CONTROL DIMENSIONS	BEHAVIOR DIMENSIONS	FUNCTION	FIRST DERIVATIVE
CUSPOIDS	FOLD	1	1	$\frac{1}{3}x^3 - ax$	$x^2 - a$
	CUSP	2	1	$\frac{1}{4}x^4 - ax - \frac{1}{2}bx^2$	$x^3 - a - bx$
	SWALLOWTAIL	3	1	$\frac{1}{5}x^5 - ax - \frac{1}{2}bx^2 - \frac{1}{3}cx^3$	$x^4 - a - bx - cx^2$
	BUTTERFLY	4	1	$\frac{1}{6}x^6 - ax - \frac{1}{2}bx^2 - \frac{1}{3}cx^3 - \frac{1}{4}dx^4$	$x^5 - a - bx - cx^2 - dx^3$
UMBILICS	HYPERBOLIC	3	2	$x^3 + y^3 + ax + by + cxy$	$3x^2 + a + cy$ $3y^2 + b + cx$
	ELLIPTIC	3	2	$x^3 - xy^2 + ax + by + cx^2 + cy^2$	$3x^2 - y^2 + a + 2cx$ $-2xy + b + 2cy$
	PARABOLIC	4	2	$x^2y + y^4 + ax + by + cx^2 + dy^2$	$2xy + a + 2cx$ $x^2 + 4y^3 + b + 2dy$

THE SEVEN ELEMENTARY CATASTROPHES

(Source: E..C. Zeeman, 1976)

Catastrophe theory is not without its share of critics. The catastrophe models and the underlying mathematics have been sharply criticised by a number of mathematicians.[60] Somewhat reminiscent of the persistent attack on general systems theory, the criticisms are not unexpected. Thom calls his theory a kind of geometrical vitalism; to him catastrophe theory is more than mathematics. It is a philosophy, a way of looking at and describing the world which then demands its own mathematics: "Catastrophe theory is not a mathematical theory, rather it deals with mathematics."[61] It is not a scientific theory, but rather a method leading to an art of models.[62]

DISCUSSION

According to Zeeman:[63] "The proof of Thom's theorem is a difficult one, but the results of the proof are relatively easy to comprehend. The elementary catastrophes themselves can be understood and applied to problems in the sciences without reference to the proof." This statement appears to have merit and the criticisms of catastrophe theory may accordingly be classified into two kinds: Criticisms that deal with the mathematical foundations of the theory, and those that deal with the effectiveness of the models. The first type lies in the domain of mathematicians and cannot be overcome at the application level;

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[60] For a summary of these criticisms see G.B. Kolata, "Catastrophe Theory: The Emperor Has No Clothes," Science (April 1977).

[61] R. Thom (1977), op. cit.

[62] R. Thom (1975), op. cit., p. 323.

[63] E.C. Zeeman (1976), op. cit., p. 65.

however, the effectiveness of the models may be tested empirically. This process is consistent with the paradigm of scientific method, which is empirical-inductive in nature. The empirical validation exercises are also consistent with the systems approach, which proceeds from the particular to the general, and infers the design of the system by a process of induction and synthesis.[64]

The interesting aspect of catastrophe theory is that it is qualitative and yet allows for dynamic investigation. This means that complex dynamic behavior can be modeled with only weak hypotheses. According to Thom, "the type and dynamical origin of a catastrophe can be described even when all the internal parameters describing the system are not explicitly known."[65]

Catastrophe models are perhaps the only ones that can handle discontinuities and divergences in behavior. For this reason alone, their descriptive effectiveness appears to be superior as compared with the existing models. However, an evaluation of catastrophe models would have to be accomplished through some empirical validation exercises, not by suppositions.

EXPLANATION OF THE CUSP CATASTROPHE MODEL

By far, the most publicized of the seven elementary catastrophes is the cusp catastrophe, also known as the Riemann-Hugoniot catastrophe. The cusp model has been used to explain sudden changes in

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[64] J.P. van Gigch, Applied General Systems Theory (New York: Harper and Row, Inc., 1974), pp. 10-11.

[65] R. Thom (1975), op. cit., pp. 60-61.

behavior resulting from a two-dimensional control. Mathematically, the cusp model is derived as follows.[66] Let

$$f(a,b,x) = \frac{x^4}{4} - ax - \frac{bx^2}{2}, \qquad (1)$$

where $f(a,b,x)$ is the energy function,

x is the coordinate on the behavior space, and
a, b are the coordinates on the control space.

The behavior surface M is given by

$$\frac{\partial f}{\partial x} = x^3 - a - bx = 0 \qquad (2)$$

A singularity occurs when

$$\frac{\partial^2 f}{\partial x^2} = 3x^2 - b = 0 \qquad (3)$$

Equations (2) and (3) define the singularity set,which consists of two folds. Thus, the behavior surface has a fold curve F, in it, as shown in Figure V. The projection of the fold curve F onto the control surface is called the bifurcation set B. The equation of B is given by eliminating x from equations (2) and (3):

$$27a^2 = 4b^3. \qquad (4)$$

Although F is a smooth curve, B has a cusp at the origin.

Zeeman[67] has postulated that five properties characterize phenomena that can be described by the cusp model:

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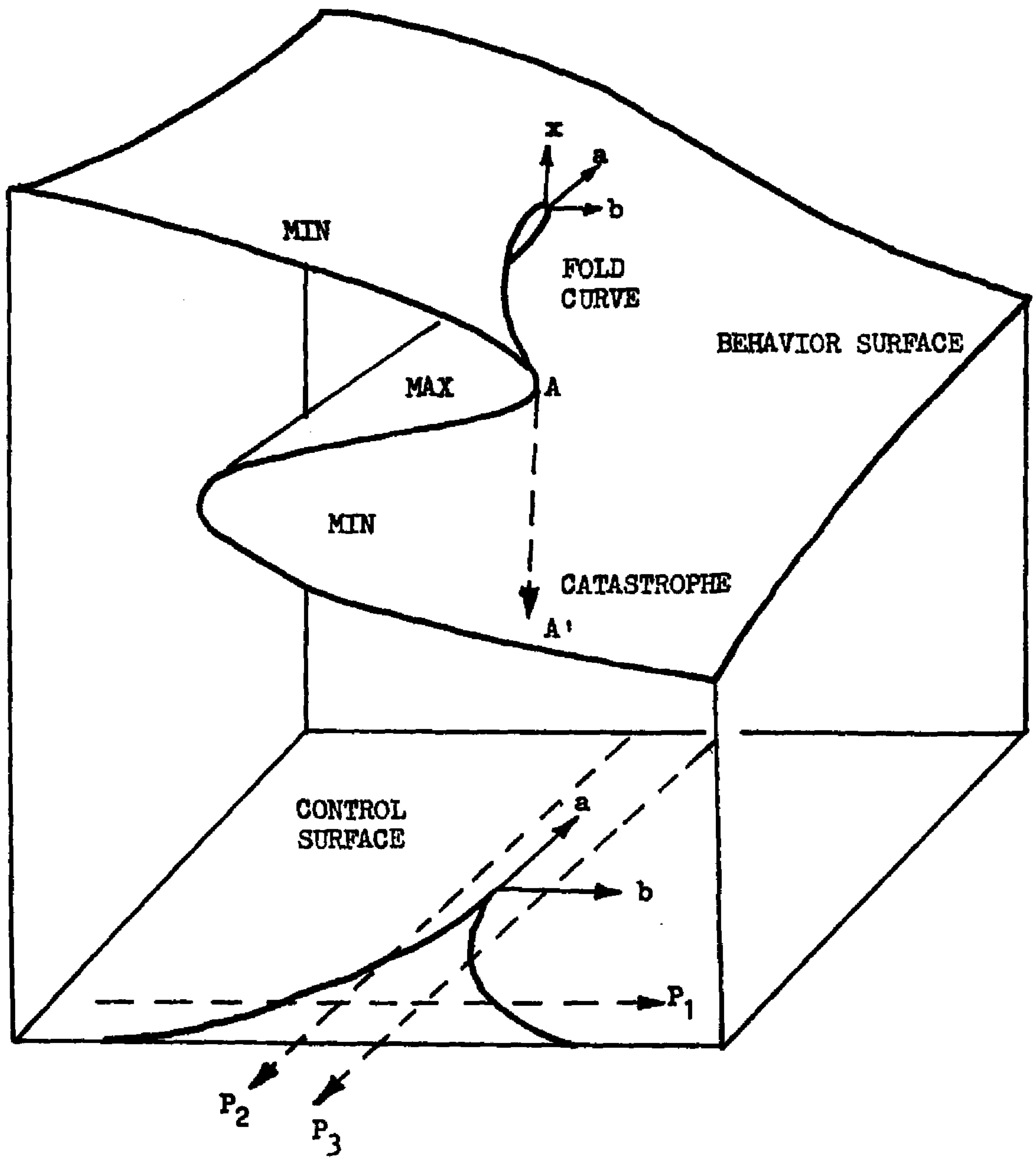
[66] Adapted from C.A. Isnard and E.C. Zeeman, op. cit. See also E.C. Zeeman (1973),op. cit.

[67] E.C. Zeeman (1976), op. cit., p. 70.

FIGURE V

THE CUSP MODEL

(Adapted from Zeeman, 1976)



1) Bimodality,
2) inaccessibility,
3) sudden transitions,
4) hysteresis, and
5) divergence.

These properties may be identified as follows:

Consider a control point c = (a,b) along the path P_1 on the control surface. If the control point c = (a,b) is <u>outside</u> the cusp then f_c (the value of the energy function at c) has a unique minimum; therefore M is single-sheeted over the outside of the cusp. For c = (a,b) <u>inside</u> the cusp, f_c has two minima separated by one maximum, thus M is triple-sheeted inside the cusp. However, the middle sheet is mathematically irrelevant since it represents maxima of f_c, hence represents the inaccessible region for applications. The two minima represent two possible modes of behavior (bimodality). For example, a dog both angry and fearful may either attack or retreat.

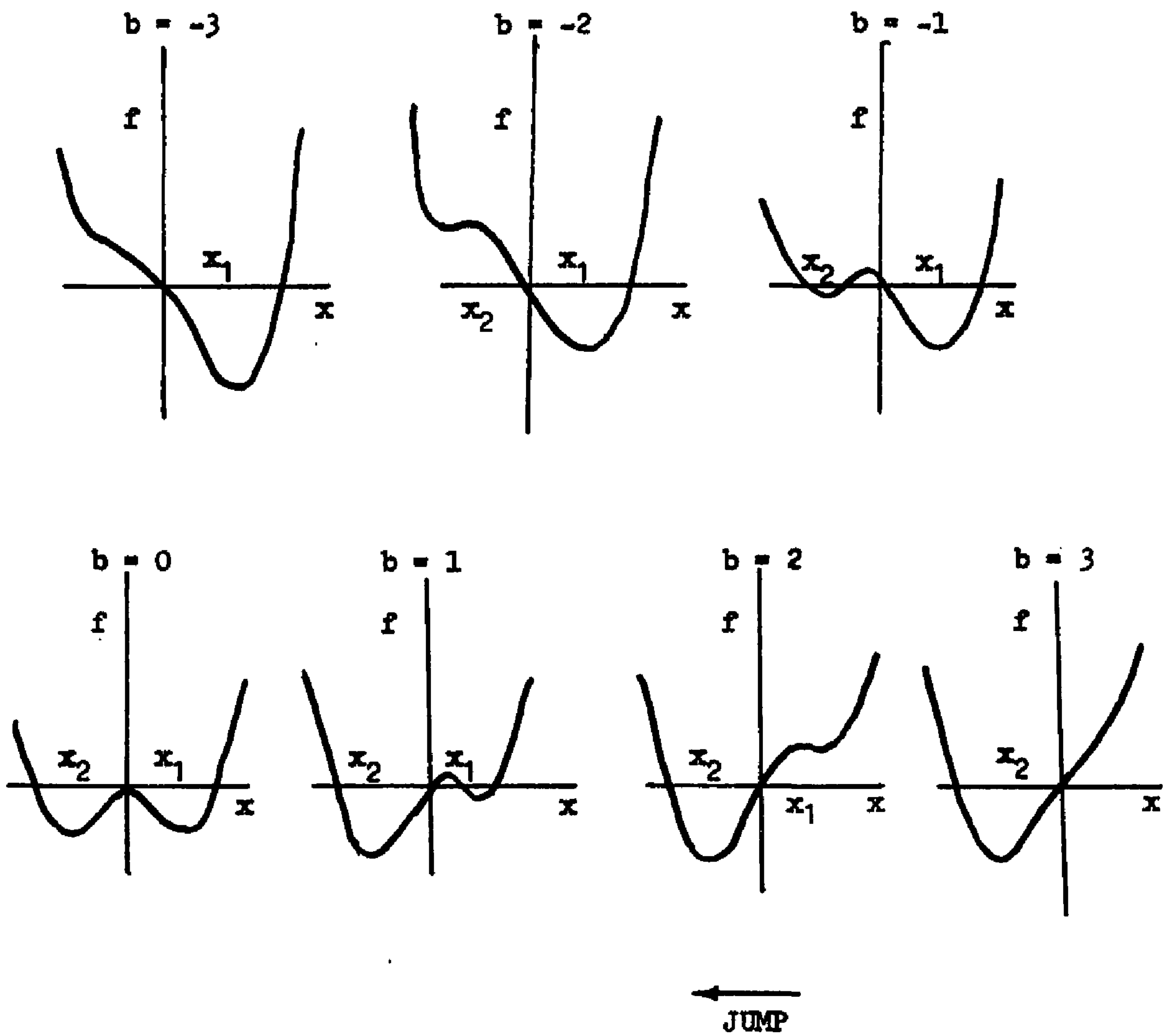
Suppose the control point c is moved smoothly along the path P_1, the behavior state x_c (the value of x at c) follows smoothly along the upper surface until it reaches a point A = (-3,2,1) on the fold curve, when it suddenly jumps to A' = (-3,2,-2) on the lower surface, after which it proceeds smoothly along the lower surface. This catastrophic change of behavior is called a sudden transition. A frightened dog in a situation in which its rage steadily increases, may suddenly attack. Figure VI shows the change in the shape of local energy function for values of b = -3,-2,...3.

At b = -3, the behavior state has the unique minimum x_1. At b = -2, a second minimum x_2 appears, but equation (1) holds the state in the first minimum x_1. Only when the second bifurcation occurs at

FIGURE VI

CHANGES IN THE SHAPE OF LOCAL ENERGY FUNCTION

(Adapted from Zeeman, 1976)



$b = 2$, x_1 becomes the maximum, and the equation (1) moves the state rapidly to x_2. If the control point is now moved along the path P_1 in the opposite direction, the return jump is delayed until $b = -2$. This delay, due to hysteresis, increases as 'a' decreases. This means that the dog suddenly attacks or retreats at different combinations of rage and fear.

The property of divergence can be observed by moving along the paths P_2 and P_3. At the beginning of the paths, the behavior states are close but are far apart at the end, P_3 being on the lower surface and P_2 on the upper surface. The two paths (which are shown to be on the either side of the cusp point) do not experience any discontinuity during the movement.

Zeeman[68] has invented a device called "catastrophe machine" to explain the dynamics of the cusp catastrophe. The underlying principle in the following description is that when the behavior of a system is subject to opposing forces, the system seeks a state of equilibrium at minimal energy. The process which keeps the system in this equilibrium is called dynamic. The catastrophe machine, illustrated in Figure VII, has been analyzed in detail by several authors.[69]

The machine consists of a pivoted disc and two rubber bands attached to the edge of the disc to provide opposing forces. The free end of one piece is fixed, while the other moves freely and is called

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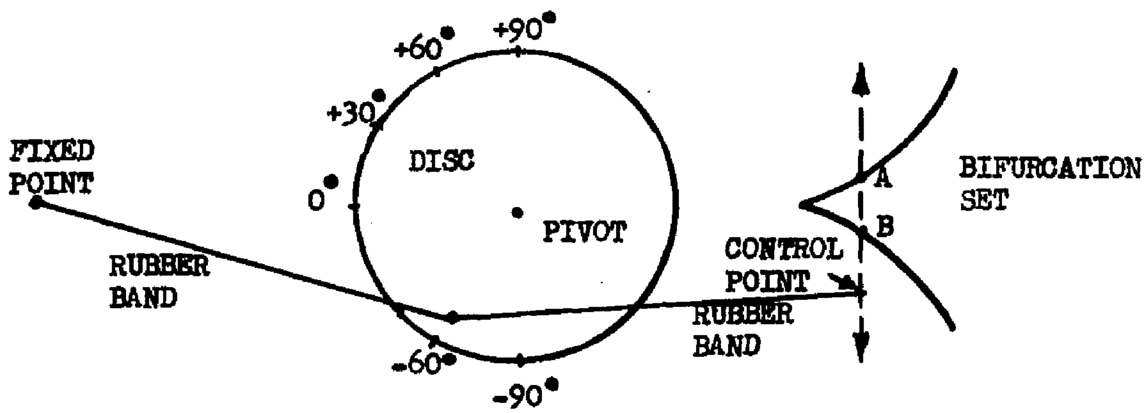
[68] E.C. Zeeman, loc. cit.

[69] T. Poston and A.E.R. Woodcock, op. cit.; I. Stewart, op. cit.; E.C. Zeeman, op. cit.; W.S. Brown, op. cit.

FIGURE VII

ZEEMAN'S CATASTROPHE MACHINE

(Adapted from Zeeman, 1976)



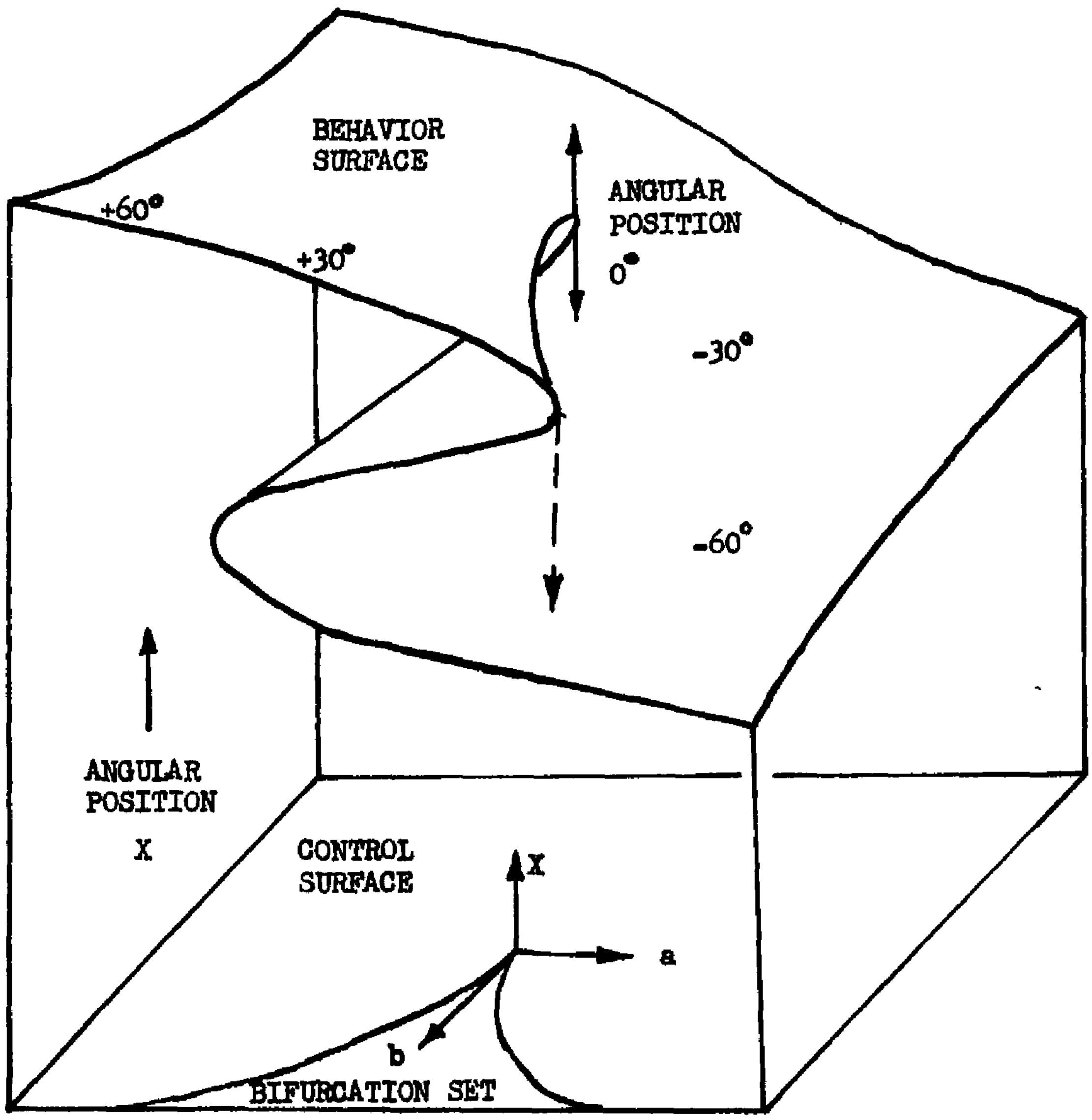
the control point. As this control point is moved in the plane of the disc, there is a smooth movement of the equilibrium position of the disc, with an occasional sudden jump in order to keep the potential energy between the rubber bands at a minimum. The positions of the control point at which the jumps occur constitute the bifurcation set. As long as the control point remains outside the cusp, the movement of the disc varies smoothly and continuously as a function of the control parameters. Even upon entering the bifurcation set, no sudden jump is observed. However, a catastrophe is certain to occur when the control point passes all the way through the bifurcation set. The cusp model of the catastrophe machine is shown in Figure VIII corresponding to the cusp closest to the disc. The model is simply a three-dimensional graph of equilibrium states x (angular positions of the disc) against the position of the control point.

The folded behavior surface represents the equilibria (minima of energy function). If the control point lies outside the bifurcation set, only one value of x is possible; but if it lies within the bifurcation set, then there are three values of x : one on the top sheet, one in the middle, and one on the bottom sheet. However, the dynamic holds behavior firmly on the top and bottom sheets, thus the middle sheet is said to be inaccessible. The dynamic also causes catastrophic jumps from one sheet to the other when the edge of the pleat is reached. Within the bifurcation set, the values of x can be determined uniquely only when the direction of movement of control point is known. Stated differently, the behavior is bimodal in some part of its range. Also, the jump from the top sheet of the behavior surface to the bottom sheet

FIGURE VIII

CUSP MODEL OF THE CATASTROPHE MACHINE

(Adapted from Zeeman, 1976)



does not take place at the same position as the jump from bottom sheet to the top one, an effect called hysteresis. The cusp model thus implies the possibility of divergent behavior, that is, at the starting point (singularity) of separation between the two behavior surfaces, the system is forced to adopt one of the two opposing behaviors.

AN APPLICATION OF THE CUSP MODEL TO COLLECTIVE BARGAINING SITUATIONS

Oliva and Capdevielle[70] have attempted to map the important structural characteristics of the Stagner-Rosen model onto the cusp catastrophe. This mapping is accomplished by establishing that the cusp model and the Stagner-Rosen model are conceptually isomorphic.

1. Bimodality: In the Stagner-Rosen model, the control dimensions are the management and union demand intensities, and the bargaining behavior of the system ranges from lockout to strike. The bifurcation set, which is defined by the management and union tolerance limits, represents the bargaining zone. Formal negotiations take place in this area of bimodality.

2. Sudden transitions: During the formal negotiations, if the management is acquiescent, unions demand intensity is likely to increase gradually. However, a lockout would result if the management tolerance limit is exceeded, indicative of sudden (catastrophic) transition in the bargaining behavior of the system. On the other hand, if the management is militant and the union acquiescent, a strike would result should the management continue to press its demands beyond the union tolerance limit.

3. Hysteresis: The preceeding discussion indicates that a strike would result if the union tolerance limit is exceeded, and a lockout would result if the management tolerance limit is exceeded. Stated differently, strike and lockout occur at different conbinations of union and demand intensities. Thus, catastrophic jumps (strike and lockout) take place at different

[70] T.A. Oliva and C.M. Capdevielle, op. cit.

positions depending on the direction of movement.

4. Inaccessibility: During formal negotiations, the bargaining parties are expected to attempt to win as many of their respective demands as possible. Therefore, a state of neutrality in the bargaining behavior of the system is not consistent with the concept of bargaining, and would be the least likely behavior.

5. Divergence: As demand intensities are increased by both parties, formal bargaining begins. Upon reaching a singularity, a small difference in the bargaining behavior of the system would move the system onto either the strike prone trajectory or the lockout prone trajectory. Stated differently, feedback effects begin to slowly change the demand intensities, which can set the system on totally different courses.

Assuming that the preceeding arguments are correct, the collective bargaining situation can be investigated using a cusp model. This model is illustrated for this application in Figure IX. The bargaining behavior surface is given by the following equation:

$$x^3 = a + bx \qquad (5)$$

where x is the bargaining behavior of the system,
a is the union demand intensity, and
b is the management demand intensity.

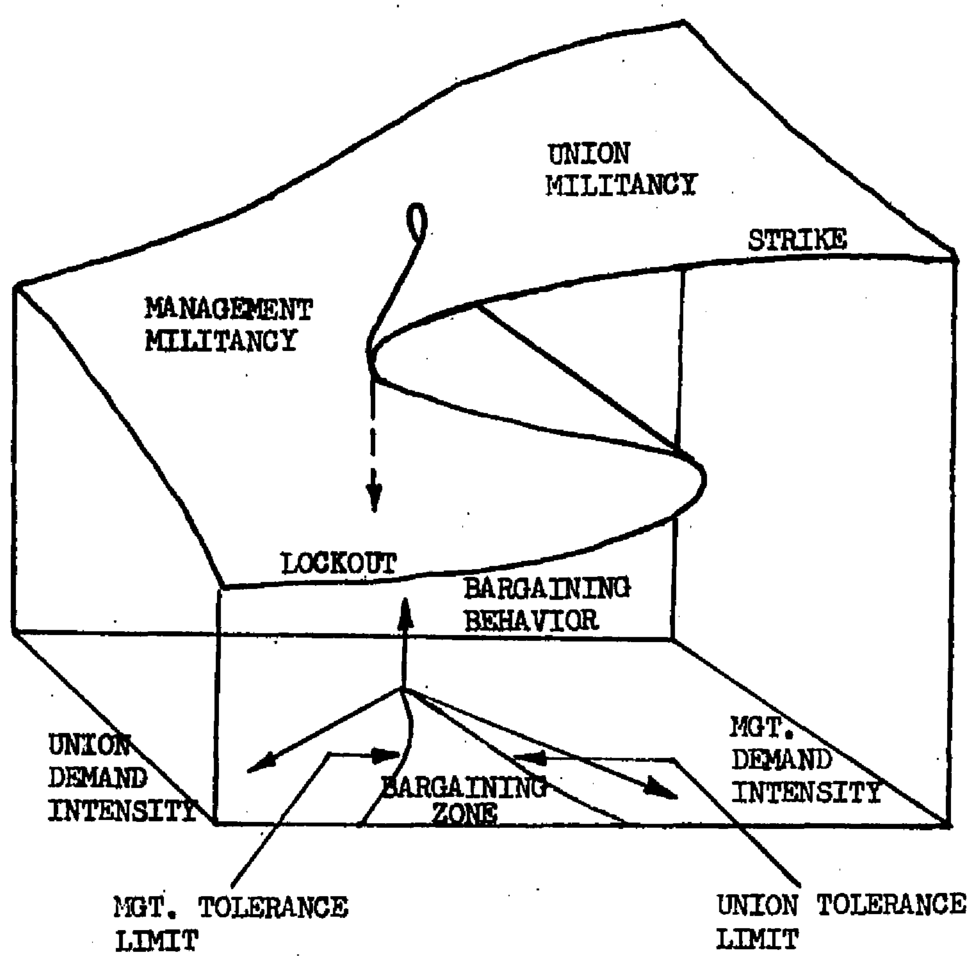
SUMMARY

Concepts relating to bargaining behavior in general and collective bargaining behavior in particular were presented in this chapter, and various models were discussed. It was shown that the existing models were not fully adequate in describing the dynamics of formal negotiations. A new generation of models called catastrophe models were examined in general, and the cusp catastrophe model in particular. A conceptual isomorphism between collective bargaining behavior phenomenon and the cusp model was indicated as a possible approach to the investigation of the

FIGURE IX

CUSP MODEL FOR COLLECTIVE BARGAINING BEHAVIOR

(Adapted from Zeeman, 1976)



dynamics of formal negotiations. It was suggested that such an investigation would also be indicative of empirical verification of the usefulness of the cusp model.

CHAPTER III

METHODOLOGY

INTRODUCTION

This chapter discusses the research methodology and procedures for the collection and analysis of data. The cusp catastrophe model for explaining the dynamic nature of collective bargaining behavior is restated and a simulation of the collective bargaining process is described as an approach to test the usefulness of the model. In this context, the working and formal hypotheses are stated and a measure of effectiveness is indicated. The method of data collection and the underlying procedures are described, including subject selection, experimental design, and the simulation procedures for this research.

RESTATEMENT OF THE MODEL

Based on Stagner-Rosen description and recent advances in catastrophe theory, a model for dealing with the dynamic aspects of collective bargaining behavior was suggested in the preceeding chapter. The model was derived by establishing an isomorphic relationship between the Stagner-Rosen model and the cusp catastrophe model. The Stagner-Rosen model postulates that both bargaining parties have certain expectations and tolerance limits which define a bargaining zone; as the parties bargain, they explore these limits in an effort to find an area in which a compromise is possible; and if these limits are exceeded, a strike or a lockout may result. The cusp catastrophe model recognises this coexistence of divergent behaviors in a system and explains the abrupt changes that sometimes occur in the system behavior by examining the cause and effect relationships that exist in the system.

In a collective bargaining process the <u>effect</u> may be defined as the bargaining behavior of the system. At any given stage of formal negotiations the system allows for divergent behavior. That is, the system may be assumed to exhibit a strike-prone behavior, or a lockout-prone behavior. Further, the system may sometimes exhibit sudden transitions in its behavior indicative of failure of negotiations in the form of a strike or a lockout. Thus the <u>effect</u> may be defined as a continuum of system behavior ranging from a strike to a lockout, with various intermediate positions of strike-prone or lockout-prone behaviors. The <u>cause</u> may be defined in terms of control variables in the system such as management and union demand intensities (expectations). The cusp model attempts to explain the changes in the system behavior when the control variables are gradually changed.

The effect or the system behavior is represented in the cusp model by a structurally stable topological surface (behavior surface) with a fold curve in it. The <u>cause</u> is a set of points (different combinations of the control variables) on a control surface. The behavior surface is derived from this set in accordance with the following causal relationship:

$$x^3 = a + bx \qquad (1)$$

where x is the <u>effect</u> or the bargaining behavior of the system,

and a, b are the control variables (<u>cause</u>), namely, the union and management demand intensities respectively.

The union and management tolerance limits are defined by the limits of the bifurcation set on the control surface. The area inside the bifurcation set (the cusp) thus identifies the bargaining zone. In this zone the system behavior is bimodal, that is, the system has two possible modes of behavior, namely, strike-prone behavior and lockout-prone behavior.

If the control variables are gradually changed, there is a smooth movement in the behavior surface either in a strike-prone trajectory or a lockout-prone trajectory. At the origin of the cusp, very small changes in the demand intensities can set the system on totally different courses. In this process, if the management is acquiescent, the union demand intensity is likely to increase gradually until the tolerance limit of management is reached at which point a sudden transition in the system behavior could occur in the form of a lockout. Alternatively, if the union is acquiescent, a strike may eventually result, should the management continue to press its demands past the union tolerance limit.

To summarize, the cusp catastrophe model considers the cause and effect relationship between the demand intensities and the system behavior for explaining the dynamic aspects of the collective bargaining phenomenon. The model attempts to explain divergent behavior and sudden transitions of behavior of the system.

Although the model has been explained in the context of union-management collective bargaining situations, it can be used to explain other collective bargaining type situations as well. For example, peace negotiations in international disputes can be modeled using the same logic of presentation. However, it is often difficult to devise a methodology to test the model in real life situations.

One possible approach to verify the usefulness of the model is through simulation of collective bargaining type situations in laboratory environments. Such simulations have their limitations, but serve as a first step in systematically examining certain aspects of the model and the dynamics of the process in general. The methodology outlined in this chapter involves a simulation of union-management collective bargaining. This simulation, called Collective Bargaining Game, is described in Appendix A.

HYPOTHESES

The following working hypotheses concerning the impact of union demand intensity (a) and management demand intensity (b) upon the bargaining behavior of the system (x) were formulated for determining the effectiveness of the cusp catastrophe model in simulated bargaining situations:

Hypothesis 1: If 'a' is constant or decreasing and 'b' is rising, then the system will exhibit strike-prone behavior, and an actual strike may eventually occur.

Hypothesis 2: If 'b' is constant or decreasing and 'a' is rising, then the system will exhibit lockout-prone behavior, and an actual lockout may eventually occur.

Hypothesis 3: If 'a' and 'b' are both constant or are both increasing or decreasing, then the system behavior will change smoothly, but feedback effects may change 'a' and/or 'b' and induce behavior described in hypotheses 1 or 2.

In order to support or fail to support these working hypotheses, the following null hypothesis was formulated:

Null Hypothesis: The cusp model is a good fit for observed collective bargaining behavior in simulated environment.

MEASURE OF EFFECTIVENESS

To test the null hypothesis, the Chi-square test for goodness of fit was deployed. This test is based on how good a fit there is between the frequency of occurence of observations in an observed sample (O) and the expected frequencies obtained from the hypothesized distribution (e). By comparing the observed frequencies with the corresponding expected frequencies, it is possible to decide whether discrepancies between the two are likely to occur as a result of sampling fluctuations. It is common practice to refer to each possible outcome of an experiment as a cell. Strike-prone behavior and lockout-prone behavior are the two outcomes considered in this experiment. Thus, there are two cells (see Table II). From the tabulated data, the quantity χ^2 is computed (after applying Yates' correction for continuity):

$$\chi^2 \text{ (Corrected)} = \sum_i \frac{(|o_i - e_i| - 0.5)^2}{e_i}$$

where o_i and e_i are the observed and expected frequencies respectively, for the ith cell, and has 1 degree of freedom.

If the observed frequencies are close to the corresponding expected frequencies, the χ^2 value will be small, indicating a good fit. If the observed frequencies differ considerably from the expected frequencies, the χ^2 value will be large and the fit is poor. A good fit leads to the acceptance of the null hypothesis. For a level of significance of .05 the critical value of χ^2 is found to be 3.841. Thus,

TABLE II

CHI-SQUARE TEST FOR GOODNESS OF FIT

	Strike-Prone Behavior	Lockout-Prone Behavior
Observed frequency (o_i)		
Expected frequency (e_i)		

$\chi^2 > 3.841$ constitutes the critical region, and falls in the right tail of the Chi-square distribution. This criterion, however, should not be used unless each of the expected frequencies is at least equal to 5.

THE METHOD OF DATA COLLECTION

Objective

The objective is to gather data on management and union demand intensities, and the bargaining behavior of the system in a simulated collective bargaining process. The data on the demand intensities take the form of indicies. These indicies and the simulation are described in the following sections.

Definitions

Union and Management Demand Intensities: These composite indicies 'a' and 'b' are developed as simple averages of the following behavioral variables measured on a 11-point attitudinal scale: extent of success in winning demands, extent of emotional involvement in the negotiations, extent to which concessions were made, extent of unwillingness to compromise, and extent of apprehension as to the equity of negotiations. Thus, the demand intensities are different from a set of demands. Additionally, the selection of components of demand intensities is not of critical importance in determining the usefulness of the cusp model, rather, the components need only be reasonable in a general sense. For example, an entirely different set of behavioral variables could have been selected, measured and averaged differently, without significantly affecting the methodology. Regression and other statistical techniques are available for variable subset selection, but there are disagreements among the contributors in this area on the measure of "goodness" of the subset of variables selected. The purpose here is not to define a universally acceptable set of behavioral variables that constitute the union and management demand intensities.

The union demand intensity is determined by multiplying the average of the suggested variables by a factor of 1.5. This factor is based on the union tolerance ratio of 2/3 suggested by Oliva and Capdevielle.[1] However, this correction factor is not of critical importance since the tolerance limits are believed to be elastic, but is helpful in conducting sensitivity analysis.

<u>Bargaining</u> <u>Behavior</u> <u>of</u> <u>the</u> <u>System</u>: The expected bargaining behavior of the system, 'e', is determined according to the working hypotheses. That is, during the formal negotiations,

(1) if 'a' is constant or decreasing, and 'b' is rising, 'e' would be strike-prone,
(2) if 'b' is constant or decreasing, and 'a' is rising, 'e' would be lockout-prone,
(3) if 'a' and 'b' are both unchanged, 'e' is determined from the previous round of negotiations,
(4) if 'a' and 'b' are both increasing, 'e' would be strike-prone if increase in 'b' is greater than increase in 'a', and lockout-prone if increase in 'a' is greater than increase in 'b',
(5) if 'a' and 'b' are both decreasing, 'e' would be strike-prone if decrease in 'a' is greater than decrease in 'b', and lockout-prone if decrease in 'b' is greater than decrease in 'a', and
(6) if 'a' and 'b' are both increasing or decreasing at the same rate, 'e' is determined from the previous round of negotiations.

The observed bargaining behavior of the system 'o' is classi-

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[1] T.A. Oliva and C.M. Capdevielle, "Collective Bargaining as a Catastrophe Model," Revised paper presented at the <u>Proceedings of Academy of Management</u> (1977b) (Unpublished).

fied as strike-prone or lockout-prone according to the observed outcome of each round of formal negotiations. Determinants of the observed outcome are, the perceptions of the subjects concerning the outcome (measured on a 10-point attitudinal scale: 0-4 = strike-prone behavior; 5-9 = lockout-prone behavior) and the record of proceedings maintained during the negotiations.

Instruments for Data Collection

The instruments for data collection consist of a collective bargaining game and questionnaire on the progress of negotiations. This game consists of renegotiation of a hypothetical agreement (see Appendix B) between pairs preselected subjects. The questionnaire (see Appendix C) provides data on the participants' demand intensities and the observed behavior state of the system for each sample of hour-long round of formal negotiations.

Subjects

The subjects for the experiment were 140 undergraduate students enrolled in four sections of Management Principles and Policies course at Louisiana State University. Of these, 86 were male and 54 female, between ages of 19 and 46, including full-time and part-time students, the latter holding management, union or non-union jobs in various organizations. The result was a rather heterogeneous sample. The subjects were induced to volunteer by offering them potential opportunities to earn up to 15 per cent extra credit in the course depending on their success at negotiations plus the prospect of being exempted from their final examination in the course if they were most successful. The subjects were not offered any monetary remuneration.

The subjects were told that they could volunteer for participating in a collective bargaining game for extra credit in the course. They were required to take a psychological test before being assigned to teams taking part in the game. The game was scheduled to be played during the regularly scheduled class meetings and did not involve negative rewards except perhaps in terms of lost opportunity to improve their grade in the course. The purpose of the experiment and the criteria for evaluating success at negotiations were not revealed to the subjects.

Experimental Design

The simulation consisted of 35 teams participating in the collective bargaining game. Each team had four subjects, two playing the role of management representatives, and the other two playing the role of union representatives. Procedures for assignment of subjects into teams are described in the following sections.

Although the purpose of this experiment was not aimed at discovering personality effects on collective bargaining behavior, it was believed that some important functions would be served if each of three basic personality types, namely, n-achievement, n-affiliation, and n-dominance orientations, played each other in all possible combinations (a 3 x 3 design). A completely random assignment would have adequately served the purpose, but the 3 x 3 design allows for blocking of certain variables and reduces the variability in the experiment. Also this design was believed to provide a representative sample to examine the entire spectrum of collective bargaining behavior. Some of the gaming experiments aimed at investigating personality effects on the collective bargaining behavior of the system lend support to the belief that personality orientations are at least <u>a-priori</u> determinants of the expected bargaining behavior of the system.[2]

<u>Blocking</u>

<u>Personality Orientations</u>: The design outlined above would allow for blocking the secondary effects of personalities of single individuals, since the collective bargaining game involves systemic configuration of personalities. That is, if pairs of subjects of a certain personality orientation were matched against every other types of pairs, there would be reduced sampling bias.

<u>Predisposition of Subjects</u>: Each personality type was subclassified as being high or low on n-nurturance and n-exocathection. N-nurturance indicates an orientation toward compassion and sympathy for less fortunate persons, while n-exocathection generally shows a practical outlook with emphasis on results, wealth, position, and competition. Such subclassifications help to identify the predispositions of the subjects with regard to management or union activities on the assumption that subjects are likely to have high n-nurturance if they sympathise with union activities in general, and high n-exocathection subjects are more likely to be biased in favor of management activities. Accordingly, pairs of subjects having high n-nurturance scores were designated as union representatives. This procedure was believed to reduce the bias due to

[2]For more details see K.W. Terhune, "Motives, Situation, and International Conflict Within Prisoner's Dilemma," <u>Journal of Personality and Social Psychology</u>, 8 (Mar. 1968).

the predispositions of the subjects on the nature of the experiment.

Sex: The effect of sex variable was partially blocked by forming all-male, all-female, and male-female combinations of teams for the experiment. Of the 35 teams that took part in the experiment, 8 were all-male, 6 were all-female, and 21 in different male-female combinations.

Motive Assessment and Grouping Procedures

The following personality orientations of the subjects were measured by responses to a psychological insight test questionnaire[3] (see Appendix D):

Primary Orientations:	1) Achievement (n-ach)
	2) Affiliation (n-aff)
	3) Dominance (n-dom)
Secondary Orientations:	4) Nurturance (n-nur)
	5) Exocathection (n-exo)

Scoring of the questionnaires was done by averaging the scores on each personality variable. Thus, each subject was classified into one of the following six groups:

Management Predisposition:	1) n-ach; n-exo
	2) n-aff; n-exo
	3) n-dom; n-exo
Union Predisposition:	4) n-ach; n-nur
	5) n-aff; n-nur
	6) n-dom; n-nur

The subjects were further classified as 'high', 'average', or 'marginal' examples of each orientation and also according to sex. Pairs of subjects

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[3] Adapted from H.A. Murray (ed.), Explorations in Personality (New York: Oxford University Press, 1938), pp. 142-242; with permission of the publisher (see Page 117).

from the first three groups were matched with pairs of subjects from the last three groups in nine possible ways, after allowing for blocking of sex and individual personality effects (see Table III). The number of teams in each cell are indicated in the table.

Simulation Procedures

After the subjects had been grouped into teams, each team was briefed on the collective bargaining game. The experimenter remained neutral and was unavailable for any consultations during the game.

The subjects were informed that the game consisted of formal negotiations between pairs of preselected subjects on an existing labor contract. All the teams negotiated simultaneously on 20 articles of agreement in chronological order, taken one at a time. Bargaining was initiated with the statement of preferred solutions and continued until a mutual agreement was reached. The subjects were permitted to declare a strike or a lockout if the negotiations failed. At the end of each session, the two bargaining sides of each team independently reported progress on negotiations by responding to a questionnaire (see Appendix B). This questionnaire provided data on a 11-point scale by assessing the perceived demand intensities of the management and union representatives, and the actual bargaining behavior of the system. The subjects were not permitted to introduce additional articles to the existing agreement, that is, they negotiated only amendments to the existing articles.

To encourage active participation, the subjects were offered payoffs in potential extra credit (up to 15% of the final grade) and were told that the most successful bargainers would be exempted from taking

TABLE III

THE 3 x 3 DESIGN

Mgt. / Union	n-ach	n-aff	n-dom
n-ach	3	4	4
n-aff	5	3	5
n-dom	3	4	4

the final examination in the course. The subjects were then given an opportunity to ask questions on the briefing.

The game consisted of a maximum of ten 1-hour sessions, although most teams finished the game in less than eight sessions. The subjects were not given any feedback during the game on how successfully they were negotiating. Upon completion of the game, the extra credit for the management and union sides of each team was announced (as also the exemptees from the final examination) and the subjects were debriefed on the game.

SUMMARY

Working and formal hypotheses, and measure of effectiveness for this research were stated in this chapter. The method of data collection and the underlying procedures were presented, outlining the experimental design and the simulation procedures.

The cusp catastrophe model was explained in the context of collective bargaining situations. This model considers the cause and effect relationship between the demand intensities and the system behavior for explaining some of the dynamic aspects of the collective bargaining phenomenon, such as divergent behavior and sudden transitions in system behavior. A simulation approach was suggested for verifying the usefulness of the model. This simulation called the collective bargaining game was described and procedures for data collection were detailed to facilitate testing of goodness of fit of the model.

A 3 x 3 experimental design was outlined and the procedures for subject selection, blocking, and the game were specified for implementing data collection. The results and findings of this research are presented in the next chapter.

CHAPTER IV

RESULTS AND FINDINGS

INTRODUCTION

This chapter presents the data set, results, and findings of this study. First, the data set from the psychologial insight test is presented in summary form and explained in terms of personality orientations of subjects and the subject sources. The composition of the 35 teams that took part in the simulation is also described. Second, the general results and the results of statistical analysis are presented. The data set for the statistical analysis is included in the appendix. Finally, the findings of the study are listed. A discussion of these findings and the conclusions are included in the next chapter.

SUBJECTS

Table IV presents the mean personality orientation scores by the three subject groups n-aches, n-affs, and n-doms. There were 44, 48, and 48 subjects in the three groups respectively. The data did not indicate any clearcut personality orientation as the subjects made significant scores on all of the orientations. However, the subjects were classified into subject groups according to their highest score among the three personality orientations. Table V shows the composition of the subject groups by different sections of data source. Interestingly, the proportion of subject groups in each section did not appear to be significantly different. This aspect was also reflected in the

TABLE IV

MEAN PERSONALITY ORIENTATION SCORES BY SUBJECT GROUPS

	n-ach	n-aff	n-dom
n-aches (n = 44)	3.70	1.89	1.99
n-affs (n = 48)	1.62	3.48	1.96
n-doms (n = 48)	1.48	2.17	4.12

TABLE V

COMPOSITION OF SUBJECT GROUPS BY SECTIONS OF DATA SOURCE

	n-ach	n-aff	n-dom
Section 1	12	14	14
Section 2	8	12	12
Section 3	10	6	8
Section 4	14	16	14
Total	44	48	48

proportion of subjects in each group accounting for the two secondary personality orientations, n-nurturance and n-exocathection. The mean scores on these secondary orientations by subject groups are shown in Table VI. It can be seen that scores on n-nurturance appeared to be more pronounced than n-exocathection.

TABLE VI

MEAN SCORES ON SECONDARY ORIENTATIONS BY SUBJECT GROUPS

	n-nur	n-exo
n-aches	3.73	3.57
n-affs	4.09	3.10
n-doms	3.51	3.49

Based on the scores of the psychological insight test and other design considerations described in Chapter III, the 140 subjects were grouped into 35 teams. Refer to Table III in Chapter III for the number of teams in each cell of the 3 x 3 design.

RESULTS

General Results

The teams were in session on the average for 7.37 rounds of formal negotiations. Four teams concluded negotiations in six rounds, 14 teams in seven rounds, and 17 teams in eight rounds. The teams spent on the average about 22 minutes on each article in the contract, the most active bargaining being accounted for by the wage clause.

The effect of actual payoff on bargaining behavior was blocked since the subjects were not told the breakdown of extra credit points between the 20 articles of agreement. They were also not informed the criteria of evaluation of success at bargaining. However, the subjects' perceptions of the relative importance of the various articles and the corresponding payoff promoted active bargaining. The actual payoff by articles of agreement for the winning side of a team are presented in Table VII. There was no payoff for the losing side. The criterion for evaluating success at negotiations depended on whether there was a substantial shift in policy by either side from status quo. For this purpose, articles 1, 5, 8, 9, 10, 12, 16, 17, and 19 in the existing contract were assumed to be in favor of management, and articles 3, 14, and 18 in union's favor. Thus, in order to win one of the articles that was a-priori in one's favor, it was only necessary to bargain for status quo. For the article on wages, however, this criterion was slightly modified, that is, if the mutually agreed wage rates showed an increase of less than 50 per cent over the existing rates, then management was deemed to have been successful. An increase of over 50 per cent made the union the winner. Based on these criteria, the records of proceedings were examined and the payoff was computed for each team (see Table VIII). This table reveals that the union representatives were overall winners in 22 teams, and the management representatives in 13 teams. In terms of the cells of the 3 x 3 design, this result is presented in Table IX.

TABLE VII

PAYOFF SCHEDULE BY ARTICLES OF AGREEMENT

Article	Winner's payoff
1	2
2	0
3	2
4	0
5	5
6	0
7	0
8	15
9	5
10	2
11	0
12	4
13	0
14	2
15	0
16	2
17	2
18	4
19	5
20	0

TABLE VIII

PAYOFF EARNED BY TEAMS

Team	Management	Union
1	8	42
2	24	26
3	23	27
4	20	30
5	2	48
6	9	41
7	28	22
8	12	38
9	12	38
10	15	35
11	20	30
12	12	38
13	27	23
14	20	30
15	18	32
16	20	30
17	17	33
18	30	20
19	42	8
20	30	20
21	35	15
22	20	30
23	15	35
24	20	30
25	28	22
26	39	11
27	35	15
28	42	8
29	30	20
30	15	35
31	21	29
32	9	41
33	29	21
34	32	18
35	22	28

TABLE IX

WINNERS OF THE GAME BY PERSONALITY ORIENTATIONS

Cell	Management	Union
n-ach vs n-ach	0	3
n-ach vs n-aff	0	5
n-ach vs n-dom	1	2
n-aff vs n-ach	1	3
n-aff vs n-aff	2	1
n-aff vs n-dom	1	3
n-dom vs n-ach	2	2
n-dom vs n-aff	4	1
n-dom vs n-dom	2	2

Results of Statistical Analysis

Table X (see Appendix E) presents the data set showing the union and management demand intensities, the expected and observed bargaining behavior of the system for each sample. The bargaining behavior is indicated as either strike-prone 's', or lockout-prone 'l'. Each sample consisted of an hour-long round of negotiations. Thus the data set consisted of 258 samples, being the total of 6 to 8 hour-long rounds of negotiations by each of the 35 teams.

The expected bargaining behavior was determined as follows: If 'a' is constant or decreasing, and 'b' is rising, 'e' would be strike-prone 's'. For example, in sample 3, 'a' decreased from 11.1 to 10.5, while 'b' increased from 5.0 to 6.4, thus 'e' was classified as 's'. If 'b' is constant or decreasing, and 'a' is rising, 'e' would be lockout-prone 'l'. For example, in sample 2, 'b' decreased from 6.4 to 5.0, while 'a' increased from 10.8 to 11.1, thus 'e' was said to be 'l'. If 'a' and 'b' are both unchanged, 'e' would be determined from the previous round of negotiations. For example, in sample 22, 'a' and 'b' were both unchanged, thus 'e' was determined from sample 21, which happened to be 'l'. If 'a' and 'b' are both increasing, 'e' would be 's' if increase in 'b' is greater than increase in 'a', and 'l' if increase in 'a' is greater than increase in 'b'. Consider sample 7 as an example of 'l', where 'a' increased from 10.5 to 11.4, while 'b' increased by a lesser amount from 4.0 to 4.2. Also notice sample 37 where 's' was estimated on the basis of relative increases in 'a' and 'b'. If 'a' and 'b' are both decreasing, 'e' would be 's' if decrease in 'a' is greater than decrease in 'b', and 'l' if decrease in 'b' is greater than decrease in 'a'. For example, in sample 25, 'a' decreased from 10.8 to 7.2, while 'b' decreased by a lesser amount from 8.0 to 6.6, thus 'e' was classified as 's'. Sample 28 is an example of the second situation. Finally, if 'a' and 'b' are both increasing or decreasing at the same rate, 'e' is determined from the previous round of negotiations. For example, in sample 218, both 'a' and 'b' decreased by an equal amount of 0.6, then 'e' was estimated from sample 217, which happened to be 'l'.

The observed bargaining behavior was classified as 's' if the teams scored it between zero and four, and 'l' if the scores were between five and nine. This information was recorded at the end of each round of negotiations.

Of the 258 samples, the observed frequency of strike-prone behavior was 96, and 162 showed lockout-prone behavior. The expected frequencies were 112 and 146 respectively for strike-prone and lockout-prone behaviors (see Table XI). By applying the Chi-square significance test it was found that the corrected χ^2 had a value of 3.051.

The data set was also classified by the two segments of the behavior surfawe, the strike-prone surface and the lockout-prone surface. The objective here was to test the two surfaces separately for goodness-of-fit. Recalling the three working hypotheses listed in Chapter III, the data points that conformed to hypothesis 1 and the relevant part of hypothesis 3 were tabulated in terms of expected and observed frequencies. These data points pertained to the strike-prone surface. The results are shown in Table XII. Notice that the observed frequencies of strike-prone behavior were 56 and 35 for hypotheses 1 and 3 respectively, while

TABLE XI

CHI-SQUARE TEST FOR GOODNESS OF FIT

	Strike-Prone Behavior (s)	Lockout-Prone Behavior (l)
Observed Frequency (o_i)	96	162
Expected Frequency (e_i)	112	146
Significance Test	χ^2 = 3.051	
Significance Level	= .05	
Power of the Test	= 90.1 %	

TABLE XII

GOODNESS OF FIT TEST FOR STRIKE-PRONE SURFACE

	Hypothesis 1	Hypothesis 3
Observed Frequency (o_i)	56	35
Expected Frequency (e_i)	72	40
Significance Test	$\chi^2 = 3.745$	
Significance level	$= .05$	

the expected frequencies were estimated to be 72 and 40. By applying the Chi-square significance test it was found that the corrected χ^2 had a value of 3.745.

By a similar procedure, data points that conformed to hypothesis 2 and the relevant portion of hypothesis 3 were tabulated. These data points pertained to the lockout-prone surface. The observed and expected frequencies were 71, 75, 76, and 70 respectively for the two hypotheses. The corrected χ^2 had a value of 0.4389 (see Table XIII).

Three instances of declared strike and two of lockout were observed during the simulation. In each of these cases the observed and expected system behavior were identical. These deadlocks were resolved by the arbitrator, and the teams were allowed to continue negotiations.

FINDINGS

The results support the null hypothesis that the cusp model is a good fit for observed collective bargaining behavior in simulated bargaining situations. The Chi-square significance test indicated that the differences between the observed and expected frequencies of the two behavior states, the strike-prone and the lockout-prone behaviors, are statistically insignificant. The power of the test was 90.1 per cent. The segments of the behavior surface independently showed a good fit for observed bargaining behavior, thus supporting all of the working hypotheses. Further, in the five instances of failure of negotiations, the observed and expected system behaviors were identical. This result indicated that the cusp model is effective in describing sudden transitions in system behavior.

TABLE XIII

GOODNESS OF FIT TEST FOR LOCKOUT-PRONE SURFACE

	Hypothesis 2	Hypothesis 3
Observed Frequency (o_i)	71	75
Expected Frequency (e_i)	76	70
Significance Test	$\chi^2 = .4389$	
Significance Level	$= .05$	

It was observed that the cusp model was basically applicable for individual data points in the data set. Due to the nature of experimental design, these data points were discrete and mutually exclusive. The reasoning here is that since the negotiations did not take place continuously over time, being scheduled at week-long intervals and since the subjects discussed different articles of agreement in different rounds, the system behavior could not be tracked over the duration of the game by individual teams in order to observe catastrophic changes in behavior. It would have been necessary for the experimenter to manipulate the control variables 'a', and 'b' over time (a steady increase or decrease of one or both of the variables) to facilitate a smooth movement on the behavior surface leading to a catastrophe. Furthermore, the initial conditions of the simulation stipulated that the movement on the control surface started at the origin of the cusp, which made it difficult to determine the direction of movement of the control point. Ideally, if the control point is moved from outside the bifurcation set into and across the cusp, a smooth movement on the behavior surface leading to a catastrophe could be observed.

However, an attempt was made to track the five observed catastrophes to observe the trends in system behavior over time. As expected, the movement on the behavior surface was not smooth and consistant results were not observed. Thus one of the findings is that a smooth and continuous movement of the control point is necessary to plot the system behavior over time.

The results were supportive of the Stagner-Rosen model for collective bargaining behavior. This finding was supported by the fact that although the system behavior was either strike-prone or lockout-prone, mutual agreement was possible in an area of compromise.

The results appeared to indicate that perceptions about the potential payoff were reflected in the demand intensity patterns of the subjects, which in turn influenced the system behavior. The effect of personality orientations on the system behavior indicated some pattern of consistancy, but no hypotheses were tested to ascertain the degree of consistancy.

SUMMARY

The results and findings of the study were presented in this chapter. A data set of 258 samples was analysed to determine the goodness-of fit of the cusp model in simulated bargaining situations. The results revealed that there was a good fit.

Some general results and the results of the psychological insight test were also included in the chapter. The results related to the outcome of the simulation, payoff earned by various teams, and the personality orientations of the winners in each team. These results were not tested for statistical significance. A discussion of the findings and the conclusions of the study are presented in the next chapter.

CHAPTER V

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

DISCUSSION

The results appear to show that experimental verification of the descriptive effectiveness of catastrophe models can successfully be undertaken. It was shown that the cusp model is a good fit for observed bargaining behavior in laboratory environments. Although the results pertained to laboratory type of situations, it is believed that the cusp model could be used to explain all types of bargaining behavior.

The cusp model appeared to be superior to the existing descriptive and normative models. First, the cusp model is mathematically elegant and can deal with multi-valuedness of variables. Second, it is a dynamic model and permits simulations to be conducted. This aspect may have implications for policy formulation. In this sense, the cusp model has potential to be used as a normative model. As a descriptive model, it is effective in describing phenomena involving sudden transitions. Finally, the model is based on sound scientific logic, on assumptions that do not appear to be unrealistic, and may be verified with relatively weak hypotheses. The model is both qualitative and quantitative.

Being one of the first attempts at empirical investigation of catastrophe models in the field of social sciences, it is difficult to evaluate the impact of this study on a comparative basis. All that can be said at this stage is that the cusp model has considerable potential in describing phenomema involving sudden transitions.

The data implied frequent movement from the strike-prone surface to the lockout-prone surface, and vice versa. This implication may erroneously suggest that catastrophic changes of behavior occur in the system rather frequently. However, a closer look at the description of the collective bargaining game indicates that the different rounds of negotiations were scheduled at week-long intervals,therefore each round had to be construed as a discrete data point. The subjects discussed different articles of the contract in different rounds. Therefore, the model was pertinent to each round rather than the entire game. In this sense, the rounds of negotiations were mutually exclusive. Accordingly, except in 5 cases out of 258, catastrophes were not observed.

The effect of payoff and personality orientations were not tested statistically. This does not pose a serious problem since the methodology permits use of any given set of variables. This explanation also serves to counter any criticisms that may arise as to the effectiveness/adequacy of the components of the control variables 'a' and 'b'.

Another possible criticism concerns the choice of dichotomous behavior states, the strike-prone and the lockout-prone behaviors. The choice of dichotomous behavior states is a very important feature of this study since the cusp model, by definition, allows only two stable behavior states. However, the findings indicate that strike-proneness or lockout-proneness does not necessarily eliminate the possibility of mutual agreement in the form of a compromise solution. Such solutions may be reached for various reasons. The implication here is that the system behavior could be strike-prone or lockout-prone even when there is mutual agreement. This finding provides a possible explanation as to why the negotiators sometimes experience dissonance and dissatisfaction at the solutions they agreed upon. This possibility is not recognised in the Stagner-Rosen model.

The payoff system used in the simulation is rather difficult to defend. Most researchers prefer to use monetary remuneration for payoff in gaming experiments. The use of extra credit points for motivating the subjects to participate in the game was based on the supposition that given an opportunity a student would like to make the best possible grade in the course. A review of the records of proceedings of the various teams that took part in the game appeared to support this supposition.

The major value of the results is in the relative success at validation of a complex model for a complex process. The cusp model was shown to be of operational value in application situations. More specifically, the cusp model appears to have considerable potential in the modelling of conflict processes.

CONCLUSIONS AND RECOMMENDATIONS

Some trends do emerge from this study which give direction to constructing a new methodology for describing conflict processes. Based on the results it would appear that the cusp model adds a new dimension to the existing descriptive and normative models of collective bargaining type behavior. While the results cannot be interpreted to provide any specific measures of accuracy, the chances of obtaining inaccurate descriptions would be smaller. The experimental design and sample size of 258 taken in this study can only be construed to indicate the possible usefulness of the cusp model but cannot provide conclusive evidence to establish its superiority over other models. Thus, based on the limited results of this study, it would be inappropriate to draw conclusions regarding the degree of superiority of the cusp model over other models. What is warranted from the results is the continuation of additional studies involving the cusp model.

Further study of the cusp model using much larger sample sizes and alternative designs might establish the descriptive effectiveness of the cusp model more conclusively. Also, more realistic results could be obtained by gathering data from real-life situations than from simulated situations, as well as situations where system behavior is tracked over time. The validity of results of this study may have been inhibited by the use of undergraduate students as surrogates for union and management representatives. However, it must be noted that the feasibility of field studies involving managers and union representatives appears to be rather limited because of the extreme difficulty involved in monitoring the bargaining process and the probe effects. Furthermore, if the cusp model should not prove useful, it may not mean catastrophe theory is not valid.

The cusp model is restricted to two independent variables and two behavior states. Further work in a higher dimensional space might be of more practical value. For example, the butterfly catastrophe model has four independent variables and three stable behavior states.

Zeeman[1] has suggested an application of the butterfly model in wage bargaining situations.

The butterfly model is derived as follows[2]: Let

$$f(a,b,c,d,x) = 1/6\, x^6 - ax - 1/2\, bx^2 - 1/3\, cx^3 - 1/4\, dx^4 \qquad (1)$$

where $f(a,b,c,d,x,)$ is the energy function, x is the coordinate on the behavioral space, and a,b,c,d are coordinates on the control space. The behavior surface M is given by

$$\frac{\partial f}{\partial x} = x^5 - a - bx - cx^2 - dx^3 = 0 \qquad (2)$$

The four control factors are called

a = Normal factor (union demand intensity),
b = Splitting factor (management demand intensity),
c = Bias factor (position in the firm), and
d = Butterfly factor (time).

When the butterfly factor is negative $(d < 0)$ then the x^4 term swamps the x^6 term, forming a cusp. The effect of the bias factor c is merely to bias the position of the cusp. When the butterfly factor becomes positive $(d > 0)$ then the x^4 term conflicts with the x^6 term and causes the cusp to bifurcate into three cusps enclosing a pocket.

This pocket corresponds to the emergence of a third stable behavior state and represents a compromise behavior midway between the two extremes behaviors represented by the upper and lower surfaces of the cusp (see Figure X). In the wage bargaining situation, the individuals

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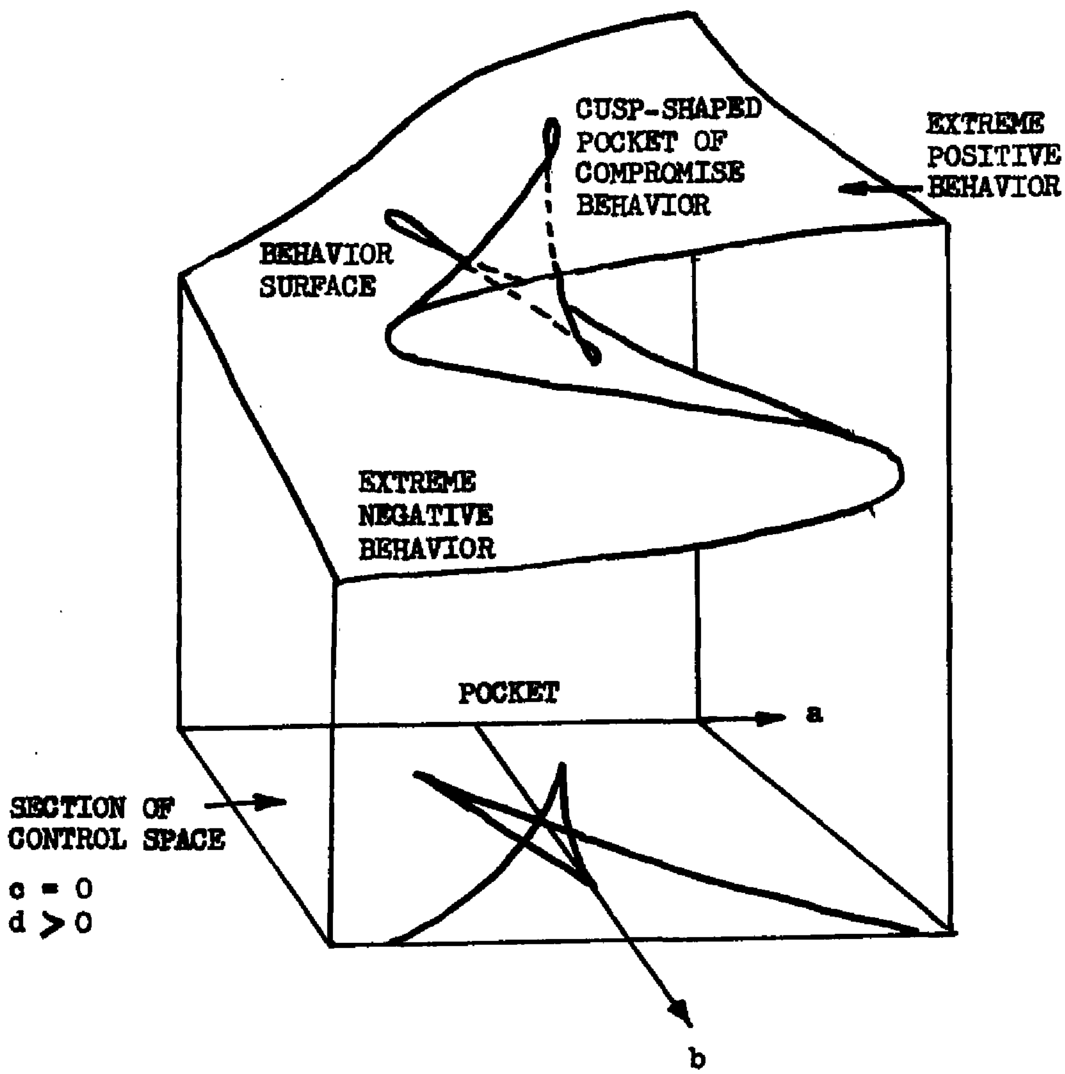
[1]E.C. Zeeman, "Catastrophe Theory," Scientific American (April, 1976). See also by the same author, "Applications of Catastrophe Theory," Tokyo International Conference on Manifolds (1973).

[2]Adapted from E.C. Zeeman, ibid. The notation is quite similar to one used in deriving the cusp model in Chapter II.

FIGURE X

THE BUTTERFLY MODEL



in the firm are represented by a cloud of points on the behavior surface moving steadily in the direction of time. For $t < 0$ the cusp catastrophe represents the polarization of opinion between the union's demands and management's offer. For $t > 0$ the compromise pocket emerges and as time progresses the pocket grows and more individuals fall into the pocket, that is, experience the catastrophe from an extreme opinion to the compromise opinion. For a given value of bias, the compromise opinion differs sharply from the extreme opinions. A wage bargain is struck when sufficient individuals fall into the pocket.

A preliminary study was conducted to examine the above description using a methodology similar to the one described in Chapter III. A simulation called Wage Bargaining Game was designed to study the goodness of fit of the butterfly model in simulated wage bargaining situations (see Appendix F). The objective here was to verify the emergence of the third stable behavior state representing compromise behavior. Accordingly, the data were collected in successive rounds of negotiations on the number of subjects moving toward compromise behavior. The results at $t=1$, $t=2$ and $t=3$ are presented in Table XIV. The expected number of subjects moving toward compromise behavior was estimated on the basis of the bias factor, for example, at $t = 1$, all those representing positions above the rank of supervisor were expected to vote for a compromise. The observed number of subjects moving toward compromise behavior was determined from the ballots that were cast at the end of each round.

The results were encouraging and indicated that the butterfly model was a good fit in wage bargaining situations in simulated environments. The corrected χ^2 values of 3.437, 0.0643, and 2.752 at $t = 1,2,3$

TABLE XIV

GOODNESS OF FIT TEST FOR THE BUTTERFLY MODEL

Butterfly Factor (t)	Frequency	Compromise	No Compromise
1	Observed (o_{11})	45	95
	Expected (e_{11})	35	105
2	Observed (o_{12})	68	72
	Expected (e_{12})	70	70
3	Observed (o_{13})	114	26
	Expected (e_{13})	105	35

Significance Test	$\chi^2_{t=1} = 3.437$
	$\chi^2_{t=2} = 0.0643$
	$\chi^2_{t=3} = 2.752$
Significance Level	$= .05$
Power of the Test	$= .724$

respectively were not statistically significant. However, the power of the test was only 72.4 per cent, being accounted by the relatively small sample size of 140. This limited finding strongly suggested the need for further research in this area on a larger scale.

Further improvement of the experimental design is warranted in future research. The Thematic Apperception Test would be a more precise instrument for measuring personality orientation of the subjects. Although a design based on personality orientation appears to be more elegant, a completely random assignment of subjects into teams might provide some insight into the extent of personality effects upon bargaining behavior. Also, selection of subjects from a source other than student population might lend greater validity to the results. The simulation could be designed so as to allow plotting of the catastrophes over time. Finally, monetary payoff schedules and large sample sizes would lend greater credibility to the results and findings.

SUMMARY

In any event, the existing models have some limitations in describing collective bargaining type behavior. The descriptive models appeared to be static, and there appear to be controversies about relevance of game-theoretic conclusions to collective bargaining type situations. Furthermore, these models appear to be less effective in dealing with sudden changes in behavior. Thus, the catastrophe models appear to be more appropriate for studying conflict processes. Further research on the validity of these models would be useful and may have relevance in many fields.

The main thrust of this study has been to suggest a tool for use by the system scientists, social scientists, and students of bargaining behavior. For this purpose, some of the catastrophe models have been described. A methodology was outlined for testing the descriptive effectiveness of one of the models (the cusp model). However, further study on a much larger scale would be helpful in making these models operational in a practical sense. This preliminary study has clearly demonstrated the need for more definitive research on the usefulness of catastrophe models. Hopefully, it is the first step in the attempt at empirical verifications of the value of some of the catastrophe models in business research.

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APPENDIXES

APPENDIX A

COLLECTIVE BARGAINING GAME

The game is played by teams of four. Two members are designated to play the role of management representatives and the other two, union representatives. The game consists of renegotiating an existing union contract (Appendix B). The contract has 20 articles and each article will be considered in chronological order, taken one at a time. Bargaining is initiated with the statement of preferred solutions and continues until a mutual agreement is reached. During the negotiations, teams are permitted to adjourn for consultations. If the teams adjourn three times without reaching an agreement, the negotiations are deemed to have failed. This failure may take the form of a declaration of a strike or a lock-out. If the teams reach mutual agreement on all of the 20 articles, or if the negotiations break down, the game is over for the respective teams. Except under unusual circumstances, a maximum of 10 one-hour sessions will be allowed for the game, and the participants may not introduce additional articles to the existing agreement, i.e., they negotiate only amendments to the existing articles.

At the end of each round of negotiations, the teams are required to provide the following information to the experimenter:

1) A summary of proceedings during the round, indicating number of articles discussed, the initial demands on each article by management and union, and the mutually acceptable solution (if reached). Should there be a breakdown of negotiations, the last positions of the management and union must be indicated.

2) The management and union representatives separately fill out a questionnaire (Appendix C) at the end of each round.

3) At the end of the game, the teams report the changes in the existing agreement, if any, that are mutually agreed upon, and the actual result of the game. The actual result could take the form of a mutual agreement or a declaration of strike/lock-out.

The game is triggered after the participants have examined the existing agreement and formulated their respective overall strategies. The management and union representatives are encouraged to write down their maximim and minimum acceptable demands on each article, along with arguments favoring these demands. For this purpose, the participants are encouraged to cite current industry and other socio-technical data. Payoff schedule for the participants is as follows:

1) A maximum of 50 points of extra credit may be earned by the participants by winning their respective demands during the negotiations. For this purpose, each article in the agreement has a potential payoff.

2) A maximum of 30 points will be awarded as a bonus credit for the overall winning side of each team.

3) A maximum of 20 points will be awarded to all participants for the reports they make during and after the game.

4) The most successful pair of bargainers in the class will be exempted from the final examination in Management 3159.

5) In case of breakdown of negotiations, as in the cases of declaration of strike or lockout, the amount of extra credit that the participants may be elegible for will be determined by an arbitrator. Professor T.A. Oliva, Department of Management, has kindly agreed to be the arbitrator.

6) The extra credit earned in this project may not exceed 15 per cent of the final grade in the semester.

APPENDIX B

A G R E E M E N T

ABC CORPORATION, Baton Rouge, herein individually referred to as the "Company", and collectively as the "employer," and ABC WORKERS UNION, herein referred to as the "Union," agree as follows:

Article 101: Coverage

The bargaining unit is made up of all production and maintenance employees of the employer, excluding professional, managerial, supervisory, and clerical employees.

Article 102: Term

The term of this agreement begins on April 1, 1976, and continues through March 31, 1978. On or before February 1, 1978, one party officially notifies the other party, in writing, that it wants to end it.

Article 103: Recognition of Union and Management Functions

The employer recognises the union as the exclusive representative of all employees covered by this agreement for the purpose of collective bargaining with respect to rates of pay, wages, hours of employment, and other conditions of employment. The union recognises that the employer has the right, on its own initiative, to perform any function of management at any time, so long as it does not violate any provision of this agreement.

Article 104: Work Stoppages

There shall be no lockouts or strikes under any circumstances during the term of this agreement.

Article 105: Grievance Procedure

A claim that the company has violated this agreement is forfeited unless it is presented within 10 calendar days after the alleged violation occurs. This is true even though a continuing violation is alleged. Union may present the grievance in writing to the department head concerned. If the department head does not hear the grievance within 10 days after the request, the union may arrange a conference with the manager. The answer made by the company must be in writting. The company's answer is final and binding, and no provisions for appeal or arbitration are provided herein.

Article 106: Order must be obeyed

When an employee feels aggrieved because of an order, he shall nevertheless obey the order, provided it does not involve serious danger to life.

Article 107: Holidays

The following days are on holiday list: New Year's Day, Good Friday, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day. An employee is elegible for holiday benefits unless he is absent without permission or is on leave of absence. The company may decide which jobs normally operate and which jobs normally close down on holidays.

Article 108: Pay

In the normal circumstances, each employee shall be paid his rate in the classification he is working for all time payable.

Classification	Rate/hour
Auto mechanic	$ 4.38
Machinist	$ 4.38
Carpenter	$ 4.38
Helper	$ 2.75
Millwright	$ 4.38
Operater	$ 4.38
Pipefitter	$ 4.38
Welder	$ 4.38

Except where this agreement says otherwise, straight time shall be payable for time worked, and when absent for these reasons:

1) Death in the family
2) Conferring with management
3) Vacation

Article 109: Overtime

Time and one-half shall be payable after the 40-hour period in a workweek. The employer may schedule an employee for overtime work with or without prior notice. In the normal circumstances, such overtime is worked after eight hours have been worked in the day.

Article 110: Hours

The workweek is a period of five consecutive days beginning with Monday. The working period is 7:45 a.m. to 4:15 p.m. with a 30 minutes lunch break. In unusual circumstances, the employer may change the workweek and the working period.

Article 111: Service

In the normal circumstances, an employee's service accumulates in his regular classification.

Article 112: Conditions which temporarily interrupt service

An employee is absent under conditions which temporarily interrupt service when he is absent from work, unless the absence is with permission, is followed by a return to work without interruption of employee status and appears on the following list:

1) An absence which has continued for not more than 10 consecutive calendar days.
2) An absence for active military service.
3) An absence while on loan by the company.
4) An absence for sickness or accident of the employee, provided a doctor certifies that the absence is necessary.
5) An absence for vacation.

Article 113: Proof of service

In computing service, the records of personnel administration department shall be conclusive.

Article 114: Seniority

One employee has higher job service than another employee if

1) He has longer service of the kind in question, or
2) Service of the kind in question is equal, and he has more service of the highest lower kind.

For purposes of determining seniority, all classifications are considered equal.

Article 115: Qualification

It is the function of management to fix the qualifications for each job and post. The determination of abilities and qualifications of an employee shall be made by the company. The company may select an employee of less seniority for a higher job on the basis of ability and qualifications rather than on the basis of seniority alone.

Article 116: Layoff

Before laying off employees, the company will notify the union of the impending layoff at least one month before its effective date. Employees scheduled for layoff will be permitted to voluntarily retire, provided they can qualify for early retirement, or voluntarily resign and receive severance pay.

Article 117: Assignment

It is the function of management to assign employees to jobs, classifications, training, and transfer. Such assignments shall be made by the company based on abilities, qualifications, seniority, and prevailing circumstances.

Article 118: Vacation

An employee is elegible for vacation during a particular calendar year if his total service since the date of his employment or reinstatement is one year or more. An eligible employee is entitled to at least two weeks of vacation as follows:

Years of total service	Weeks of vacation
less than 5	2
5	3
10	4
20	5

The vacation shall be scheduled according to a preselected vacation list in one period, except in unusual circumstances. Deadline for making selections shall be April 1 of each year. Weekends and holidays shall not be excluded from vacation period. When the calendar year ends, the employee loses all of the vacation he has not yet taken. In unusual circumstances, the company may recall an employee on vacation.

Article 119: Miscellaneous

The company may discipline an employee if he commits one of the posted offenses, with or without advance notice. Even though an employee does not commit a posted offense, his conduct or work performance may still be a cause for discipline. When the company disciplines an employee, it may impose any penalty which it deems appropriate. If the penalty imposed is discharge or suspension in excess of 10 working days, the employee may appeal to determine if the penalty was imposed after due process; however, reasonableness of penalty itself will not constitute ground for appeal.

Neither the company nor the union shall discriminate against any employee because of race, color, religion, sex or national origin or because of membership or nonmembership in any labor organization. The company will also not discriminate or penalize in any way any union representative or any member of the bargaining unit because of any action taken by him in pursuant to the provisions of this agreement.

Article 120: Benefit plan

Nothing in this agreement shall affect the company's benefit plan (a. Annuity plan; b. long-term disability insurance plan; c. Accidental death benefit plan; d. Contributory group life insurance plan; e. Family health insurance plan) or the administration thereof. The union waives its rights to bargain the provisions of the company's benefit plan.

IN WITNESS WHEREOF, the parties have caused this agreement to be executed at Baton Rouge, Louisiana, on this 31st day of March, 1976.

Witnesses:

(signed) ____________________

(signed) ____________________

(signed) ____________________

ABC Corporation, Baton Rouge

By (signed) ____________________
Manager

____
Assistant Manager

ABC Workers Union

By (signed) ____________________
President

(signed) ____________________
Secretary-Treasurer

APPENDIX C

PROGRESS ON NEGOTIATIONS

Team # ________ Names: ____________________

Round # ________ Date: ____________________

Directions: Read each of the following questions carefully and evaluate the day's progress by placing an x on the scales given (0 = to no extent, 5 = to some extent, and 10 = to a very great extent):

	0 1 2 3 4 5 6 7 8 9 10
1. To what extent were you successful in winning your demands?	______________________
2. To what extent did you have to make concessions during this round?	______________________
3. How would you evaluate your unwillingness to compromise on the issues discussed in this round? . .	______________________
4. To what extent were you emotionally involved in the negotiations?	______________________
5. To what extent were you apprehensive as to the equity of negotiations?	______________________
6. In an overall sense, how would you characterize the emerging trends in the negotiations? (0 = strike inevitable, 9 = lockout inevitable)	______________________

APPENDIX D

PSYCHOLOGICAL INSIGHT TEST
(Adapted from H.A. Murry, 1938)

<u>Directions</u>: In this test you are asked to compare your behavioral and emotional reactions with those of most persons of your age - with the hypothetical average among college students.

Read each statement carefully and make up your mind whether it is more or less true for you than it is for the average. Then, make a check in the proper column.

	Below Average			Above Average		
	-3	-2	-1	+1	+2	+3
I enjoy organizing or directing the activities of a group, team, club, or committee						
I am driven to ever greater efforts by an unslacked ambition						
I am in my element when I am with a group of people who enjoy life						
I take pains not to hurt the feelings of others						
I can deal with an actual situation better than I can cope with general ideas and theories						
I argue with zest for my point of view against others						
I feel that nothing else which life can offer is a substitute for great achievement						
I become very attached to my friends .						
I will take a good deal of trouble to help a younger man - to get him a job, to intercede for him or in some other way to further his interests						
I have a rather good head for business						

	Below Average -3	-2	-1	Above Average +1	+2	+3
I find it rather easy to lead a group of persons and maintain discipline						
I feel that my future peace and self-respect depend upon my accomplishing some notable piece of work						
I give myself utterly to the happiness of someone I love						
I go out of my way to comfort people when they are in misery						
I like being in the thick of action . .						
I usually influence others more than they influence me						
I set difficult goals for myself which I attempt to reach						
I feel 'out of sorts' if I have to be by myself for any length of time						
I enjoy the company of younger people .						
I am interested in everything that is going on in the world: business, politics, social affairs, etc.						
I am usually the one to make the necessary decisions when I am with another person						
I work with energy at the job that lies before me instead of dreaming about the future						
I like to hang around with a group of congenial people and talk about anything that comes up						
I give my time and energy to those who ask for it						
I am extremely interested in the activities of other people						

	Below Average -3	-2	-1	Above Average +1	+2	+3
I feel that I can dominate a social situation						
When my own interests are at stake, I become entirely concentrated upon my job and forget my obligations to others						
I make as many friends as possible and am on the lookout for more						
People are apt to tell me their innermost secrets and troubles						
I like to do things with my hands: manual labor, manipulation or construction . .						
I feel the sense of power that comes when I am able to control the action of others						
I enjoy relaxation wholeheartedly only when it follows the successful completion of a substantial piece of work						
I accept social invitations rather than stay at home alone						
I am easily moved by the misfortunes of other people						
I am a practical person, interested in tangible achievement						
I assert myself with energy when the occasion demands it						
I feel the spirit of competition in most of my activities						
If possible, I have my friends with me wherever I go						
I am drawn to people who are sick, unfortunate or unhappy						
I like to have people about me most of the time						

	Below Average -3	-2	-1	Above Average +1	+2	+3
I feel that I should like to be a leader and sway others to my opinion						
I work like a slave at everything I undertake until I am satisfied with the result						
I am desperately unhappy if I am separated from the person I love						
I am especially considerate of people who are less fortunate than I						
I would rather take an active part in contemporary events than read and think about them						
I feel that I am driven by an underlying desire for power						
I enjoy work as much as play						
I make a point of keeping in close touch with the doings and interests of my friends						
I feel great sympathy for an 'underdog' and I am apt to do what I can for that person						
Money and social prestige are matters of importance to me						

APPENDIX E

TABLE X

DATA SET (258 Samples)*

a	b	e	o
10.8	6.4	1	1
11.1	5.0	1	1
10.5	6.4	s	1
12.6	6.4	1	1
10.2	7.2	s	s
10.5	4.0	1	s
11.4	4.2	1	1
11.4	4.0	1	1
6.6	6.6	1	1
10.8	6.0	1	1
11.7	4.8	1	1
8.7	6.0	s	1
9.9	6.0	1	1
8.7	6.4	s	s
6.6	6.4	1	1
8.7	5.0	1	1
9.3	4.6	1	1
8.1	6.6	s	s
8.7	3.2	1	s
9.0	6.8	1	1
9.3	4.6	1	1
9.3	4.6	1	1
8.7	7.2	1	1
10.8	8.0	1	1
7.2	6.6	s	s
7.2	6.6	1	1
9.9	5.8	1	1
9.0	4.8	1	1
9.9	4.8	1	1

*All figures are means except 'e' and 'o' which are abbreviated as: s = Strike-Prone Behavior; 1 = Lockout-Prone Behavior.

TABLE X (cont.)

DATA SET (258 Samples)

a	b	e	o
11.7	4.6	l	l
10.5	4.8	s	l
10.5	3.6	l	l
7.5	5.6	s	s
8.4	4.0	l	l
7.5	5.6	s	s
7.5	5.6	s	s
7.2	3.6	l	s
8.4	5.2	s	l
10.2	5.2	l	s
9.3	5.8	s	l
9.3	5.4	l	l
9.0	6.4	s	s
8.4	6.4	s	s
7.2	6.4	s	s
6.0	3.2	l	l
4.8	3.2	s	l
6.0	6.6	s	s
7.2	7.0	l	l
5.1	6.6	s	s
5.7	4.4	l	l
6.0	3.2	l	l
8.4	5.4	l	l
7.5	4.8	l	l
9.0	6.8	l	l
9.6	6.8	l	l
10.5	6.0	l	s
10.5	8.0	s	s
9.6	8.0	l	l
5.4	4.4	l	l
8.4	5.4	l	l
8.1	6.2	s	l
7.5	4.8	l	l
8.1	5.8	s	l
7.2	5.4	s	s
7.2	5.8	s	l

TABLE X (cont.)

DATA SET (258 Samples)

a	b	c	o
6.9	3.6	1	1
8.7	3.0	1	1
10.5	4.4	1	1
8.1	4.4	s	s
7.5	5.4	s	s
8.4	5.4	1	1
8.7	5.0	1	1
10.8	6.6	1	s
12.3	5.0	1	1
7.8	6.8	s	1
10.5	5.8	1	1
9.3	6.8	s	1
8.1	6.2	s	s
7.8	6.8	s	s
7.8	6.2	1	s
10.2	5.6	1	1
6.8	6.0	s	1
10.2	7.2	1	1
9.0	6.4	s	1
7.8	6.2	s	s
5.7	5.8	s	s
5.7	6.2	s	s
9.0	6.2	1	s
6.9	7.4	s	1
8.7	6.8	1	1
7.5	7.8	s	s
6.9	7.8	s	s
5.7	7.0	s	s
6.9	7.8	1	s
5.7	7.8	s	s
6.0	5.2	1	s
8.4	6.2	1	1
4.2	7.0	s	s
7.5	6.2	1	1
6.3	6.2	s	s
7.2	6.2	1	s
5.4	4.6	s	s
5.4	6.2	s	s

TABLE X (cont.)

DATA SET (258 Samples)

a	b	c	d
9.3	7.6	l	s
9.9	7.0	l	l
7.5	7.0	s	s
10.2	5.0	l	l
6.0	3.4	s	l
4.8	4.2	s	s
4.8	5.0	s	s
12.3	6.4	l	l
9.9	8.2	s	s
9.6	4.4	l	l
8.7	6.6	s	l
4.8	5.8	s	l
5.1	6.2	s	s
4.8	6.2	s	s
13.8	6.4	l	l
11.7	6.4	s	s
10.8	6.6	s	s
10.8	6.2	l	l
9.6	5.6	s	l
7.5	7.6	s	s
9.6	6.8	l	l
9.6	5.6	l	l
10.2	4.4	l	l
8.1	6.2	s	l
7.8	5.8	l	l
9.6	5.6	l	l
6.3	6.0	s	l
11.4	5.4	l	l
8.1	4.4	s	l
8.1	5.4	s	s
9.6	8.6	l	s
9.3	7.6	l	l
6.3	8.0	s	s
9.3	7.4	l	l
7.2	9.2	s	s
7.5	9.2	l	l
7.5	8.0	l	l

TABLE X (cont.)

DATA SET (258 Samples)

a	b	e	o
8.4	3.8	l	s
6.6	4.2	s	s
7.5	2.6	l	l
7.8	5.8	s	l
9.3	6.2	l	l
9.3	6.2	l	l
6.6	5.4	l	l
9.9	4.6	l	l
10.8	5.8	s	l
9.3	7.2	s	s
3.9	5.8	s	l
8.1	5.4	l	l
9.0	8.2	l	l
9.0	7.6	l	l
8.1	6.6	l	l
8.1	4.8	l	l
9.3	6.2	l	l
6.6	7.8	s	l
8.1	6.6	l	l
8.1	4.8	l	l
6.0	6.0	l	s
9.3	4.4	l	l
8.1	6.0	s	l
10.2	5.6	l	l
6.9	6.8	s	s
8.7	6.6	l	l
7.8	4.6	l	l
8.1	4.4	l	l
6.9	8.4	s	l
6.9	5.8	l	l
7.2	5.4	l	l
7.5	6.4	s	s
6.9	6.8	s	s
6.6	4.8	l	l
7.2	4.4	l	l
7.5	4.4	l	l

TABLE X (cont.)

DATA SET (258 Samples)

a	b	e	o
7.2	5.4	l	l
6.3	7.2	s	s
7.8	6.0	l	l
6.9	5.4	s	l
7.2	5.4	l	l
6.3	7.2	s	s
10.8	4.6	l	l
10.5	6.2	s	s
9.9	6.0	s	l
10.5	6.4	l	l
10.8	4.6	l	l
10.8	4.6	l	l
10.8	6.4	l	s
9.0	3.2	l	l
10.8	3.2	l	l
9.3	5.2	s	s
11.1	4.8	l	l
10.5	4.4	s	s
8.1	4.6	s	s
8.1	4.8	s	s
6.9	4.6	l	l
7.2	5.2	s	s
7.5	5.6	s	s
6.9	4.6	l	l
7.2	6.2	s	l
6.9	6.2	s	s
6.9	6.2	s	s
9.0	6.8	l	l
8.7	5.8	l	l
9.0	6.8	s	s
9.3	6.8	l	l
8.7	6.2	l	l
7.5	5.6	s	s
7.2	4.8	l	l
7.5	4.8	l	l

TABLE X (cont.)

DATA SET (258 Samples)

a	b	e	o
9.3	9.0	1	1
8.1	7.2	1	1
7.8	8.0	s	s
6.9	7.4	s	s
8.4	6.2	1	1
6.9	5.6	s	1
6.9	7.4	s	s
6.9	8.0	s	s
12.0	8.0	1	s
6.9	8.0	s	s
9.9	5.4	1	1
6.9	7.6	s	s
10.5	5.8	1	1
10.2	5.8	s	s
9.6	7.6	s	s
9.6	8.0	s	s
10.8	7.8	1	1
8.4	6.6	s	1
9.9	5.8	1	1
9.6	5.0	1	1
10.2	5.4	1	1
10.5	5.3	1	1
10.8	5.3	1	1
11.7	6.8	1	1
3.0	2.0	s	s
10.5	6.0	1	s
9.6	6.6	s	s
8.7	6.2	s	1
9.6	5.8	1	1
9.6	6.0	s	s
9.6	6.6	s	s
11.4	4.4	1	1
12.6	5.2	1	1
10.2	6.6	s	s
12.0	4.4	1	1
12.3	9.0	s	s
13.2	9.8	1	1
12.3	9.8	s	s
12.0	9.8	s	s

TABLE X (cont.)

DATA SET (258 Samples)

a	b	e	o
6.3	7.0	s	l
11.4	6.6	l	l
9.3	6.2	s	s
9.0	7.2	s	s
9.3	6.6	l	l
9.3	6.2	l	l
10.2	6.2	l	l
11.4	4.4	l	l

APPENDIX F

WAGE BARGAINING GAME

The game is played by four employee representatives. They are gathered to discuss a pay package recommended by an arbitration committee. This package has been individually rejected by the employee representatives, but due to various pressures they have agreed to formally discuss the issues. Progress on the package negotiations thus far is presented below:

		Proposed Pay Rise			
Position	#	Initial Mgt. offer	Initial employee demands	Arbitrators' recommendations	Final employee demands
Above rank of Supervisor	5	20%	40%	30%	35%
Supervisor	15	15%	40%	20%	30%
Skilled workers	150	10%	40%	15%	25%
Semi-skilled/ unskilled	240	6%	40%	10%	20%

Additional information:

1. Positions of the rank of supervisor and above are not protected by union contract.
2. The organization is labor-intensive.
3. There is one representative for each of the four groups.
4. The state of the economy is contemporary.
5. The Government may intervene if a compromise is not reached.

Rules of the game:

1. Representatives will debate whether to accept or reject the pay package recommended by the arbitrators. At the end of a 20-minute session, the team will vote whether to continue to hold out. If the package passes unanimously, the game is over.

2. Each representative completes a questionnaire at the end of the session.

3. If the package is rejected, three additional 20-minute sessions may be called to order to end the deadlock. These other sessions are presumed to take place in 30-day intervals. During this period, the company is not functioning.

4. New proposals are not permitted. The package must be considered in its entirety. A record of proceedings will be maintained for each session.

TABLE XV

PAYOFF SCHEDULE FOR WAGE BARGAINING GAME

Session I	Above rank of Supervisor	Supervisor	Skilled	Semi-skilled/ Unskilled
Compromise	12	8	3	2
No compromise	0	2	5	6
Session II				
Compromise	6	10	5	4
No compromise	4	2	5	6
Session III				
Compromise	6	8	5	2
No compromise	4	6	0	2
Session IV				
Compromise	4	3	4	1
No compromise	0	0	0	0

Five additional points will be awarded for all participants for the information they provide during the game.

VITA

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Dean of the Graduate School

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